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APPLICATION OF CENTRAX SEPARATION PROCESS TO LIQUID PRODUCTS FROM TEN DIFFERENT COPROCESSING SLURRY SAMPLES

FINAL REPORT

Sandwell Technologies

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by

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Sandwell Technologies

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The opportunity to demonstrate the capability of the Centrax Process is appreciated greatly by Sandwell Technologies.

Dr. Fouda's assistance and guidance as the Scientific Authority for this study was invaluable.

INTRODUCTION

The effectiveness of the separation of inert solids from the mixtures of liquid hydrocarbons significantly affects the net yield of liquid products from such mixtures. This is particularly true for the deashing of products of coal liquefaction which contain both non-distillable liquids and unconverted coal and ash. Sandwell Technologies, a Division of Sandwell and Company Limited, has developed a patented process which achieves a very high level of solids separation and liquid product recovery. This process, called Centrax$_{TM}$ Separation was developed by Sandwell, through participation in the CANMET shared-cost coal conversion program.

The Centrax Process is a general process for the deashing of hydrocarbon mixtures containing distillables and non-distillables. The process uses a process-derived extractant to extract the liquid products and positive separation forces generated by centrifugal action to separate the liquid and solid phases. Although, originally developed for coal liquefaction products, the process has potential applications to other mixtures containing fine solids and where relatively large quantities of high molecular weight compounds are present that cannot be separated from the solids by other deashing technologies.

EMR, Canada requested Sandwell to investigate the performance of the Centrax Process on ten different slurry product samples from CANMET coprocessing on a laboratory-scale.

The experimental program designed by Sandwell Technologies, consisted of three parts. Initially, an examination of physical and chemical properties of the samples was performed. This was followed by preliminary separation/extraction investigations carried out at different process conditions. The techniques, procedures and concepts used in this study had been previously developed by Sandwell in earlier phases of the Centrax development. Finally, these results formed the basis for proposing one Centrax process configuration and the samples were processed using this configuration.

Material balance flow diagrams have been developed using this possible multi-stage process configuration and a discussion of the scale-up of Centrax is presented.

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1.0 SUMMARY/CONCLUSIONS

1.1 Summary

The Centrax Process was applied to ten different slurry samples from CANMET coprocessing.

The slurry samples were characterized as to physical and chemical properties. These included: concentration of oil, asphaltenes, pre-asphaltenes, unconverted coal and ash, boiling point distributions and visual observations.

Preliminary separations/extractions were carried out in a batch mode to investigate the effect of temperature of separation, amount of extractant and type of extractant on ash removal and liquid product recoveries.

Based on these preliminary investigations a multi-stage counter-current process configuration was developed. Separation/extractions simulating this process were carried out. Material balance flow diagrams were constructed from the results of these simulations. A discussion of the scale-up is presented.

1.2 Conclusions

- Total liquid recovery by the Centrax Process is in the range of 95-100% for the ten samples. By comparison, recoveries by deep vacuum evaporation are in the order of 26-56%. In addition,

1.0 SOMMAIRE/CONCLUSIONS

1.1 Sommaire

Le Procédé Centrax a été appliqué sur dix échantillons fournis par CANMET a partir du procédé de co-traitment.

Les échantillons ont été d'abord analysés pour déterminer leur propriétés physiques et chimiques. L'analyse inclue détermination des concentratios des huile, asphaltènes, pre-asphaltènes, charbon nonconverti et cendres, distribution des points d'éboullition et une observation visuelle.

Des éssayes préliminaires ont été effectues au but de investiguer l'effect des différentes témperatures de séparation, et des différentes quantitées et types de extractant sur l'enlévement des cendres et la récuperation des produits liquides.

Basé sur cettes investigations préliminaires Sandwell Technologies a développé une configuration du procédé incluant des multiples passes contre-courant. En suite, plusiers simulations de ce procédé de séparation/extraction ont été effectues. Des bilans des matériaux et diagrammes de débits ont été construits. En ce qui suive sera présente une discussion concernant les procédures pour augmenter l'echelle de application.

1.2 Conclusions

- L'application du Procédé Centrax pour la récuperations du produit liquide dans les dix échantillons soumis a donné des résultats de 95-100%. Par comparaison, le degrée de

deep vacuum evaporation results in a very hard, difficult to process non-friable residue with considerable THF soluble material trapped in the solids matrix.

récuperation achevé a l'aide du vide avancé est seulement de 26-56%. En plus l'evaporation l'aide du vide avancé a comme résultat un resídu dur non-friable, contenant beaucoup de matière soluble en THF captée dans la matrice solide, ce qui fait qu'il soit trés dificil a traiter.

- Ash concentrate obtained by the Centrax Process does not contain THF soluble materials and has good friable properties allowing for conventional and easy inter-transportation.

- Le concentré de cendres obtenu par l'application du Procédé Centrax ne contient pas de matières solubles en THF et ces propriétés defriabilité sont bennes, ce qui permetra le transport facile par des méthodes conventionnelles.

- Use of non-extractant in the first separation stage might not be the optimal procedure to follow with non-aged or 'fresh' material.

- Pour le traitment des matériaux "fraiches" ou 'non-agees' l'utilisation du non-extractant n'est probablement pas la procédure optime.

- The experimental findings might be seriously confounded due to the aging of samples.

- Les résultats expérimentales peuvent être sérieusement brouillés si les échantillons traités soit agés.

- Efficiency in extraction of asphaltenes and pre-asphaltenes in the first and possible subsequent stage or stages is likely to be very different than reported here, given wider choice of extractant and available fresh material.

- L'efficacite de l'extraction des asphalténes et pre-asphalténes dans la premiere passe et possiblement dans les passes suivantes pourait être trés différente de celle obtenue dans ce travail si le matériel aurait été frais et sil y avait eu plus de choix d'extractants.

- Separated solids cakes are very difficult to handle due to their very viscous, 'sticky', plastic-type of properties and are best handled by specially designed mechanical equipment such as, the pilot plant Centrax Separator.

- Les croutes des solides sépares sont trés dificiles a manipuler a cause de leur propriétées plastiques, leur viscosité et adhérence et ils sont mieux manipulées par des dispositifs mécaniques tel que le systeme pilot Séparateur Centrax.

- Successive additions of extractant to the solids cake improves the handling of the solids due to a dramatic change in the physical properties of the cake from viscous - 'sticky' - plastic, to incompressible - abrasive material.

- Extensive difficulties were encountered in processing of the samples due to the non-homogeneous nature of the samples as exhibited by the significant precipitation of asphaltenes and pre-asphaltenes at room and elevated temperatures.

- Investigation of the different Centrax process parameters led to the following specific findings as obtained for the ten samples:

  - Asphaltene and pre-asphaltene recoveries of 69 - 95% were achieved by the non-optimized four-stage counter-current process configuration.

  - Ash concentrations of as low as zero to 0.03% can be achieved in the liquid product.

  - Precipitation of asphaltene and pre-asphaltene components can be reduced in certain process configurations by removing the lower boiling point components prior to the separation/extraction procedure.

- Le traitement de la croute des solides est améliore par additions successives d'extractant menant a un changement dramatique des propriétés physiques de la croute qui change d'un materiel viscoeux - 'collant' - plastique à un matériel incompressible et abrasive.

- On a eut des difficultées majores dans le traitement des échantillons fournis a cause de leur non-homogénèité resultant en précipitation considérable des asphalténes et pre-asphalténes autant à la témperature élévées.

- L'investigation des differents paramétres du Procéde Centrax utilisant le dix échantillons fournis, ont méné aux conclusions suivantes:

  - Par l'application d'une configuration a quatre passes contre-curant, non-optimisée, récuperations des asphalténes et pre-asphalténes de 69-95% ont été achevées.

  - La concentration de cendre dans le produit liquide peut être réduite jusqu'a niveaux de zero a 0.03%.

  - On peut réduire la precipitation des composants des asphalténes et pre-asphalténes dans certains configurations du procédé par l'enlévement des composants qui ont le point d'éboullition bas avant de passer a l'étape de separation/extraction.

- There was no recovery of pre-asphaltenes and very little, if any, recovered asphaltenes during the flash evaporation stage.

- During the flash evaporation stage, gas production can be reduced to zero.

- The ash is separated from the process in a stream that is 100% THF insoluble.

- Il n'y avait pas de pre-asphalténes et trés peu (ou pas du tout) de asphalténes recuperées pendant l'etape de vaporisation instantanée.

- Durant l'étape de vaporisation instantanée, la production de gas peut être reduite a zero.

- Les cendres sont séparées sous forme d'une coulée qui est 100% insoluble en THF.

2.0 RECOMMENDATIONS

Upon completion of this application study and analysis of results, the following is recommended:

- Investigate different ways of incorporating the separation process into the overall processing scheme with possible resultant benefits of, for example:
  - availability of a better extractant(s)
  - minimization of processing units.
- Determine the effect of aging on the performance of the Centrax Process on a laboratory-scale.
- After completion of the above recommendations, carry out a preliminary economic evaluation with regard to the benefits of employing a single stage versus multiple separation stages taking into account the benefit of recovering of additional product and the differences in 'solids' handling problems.
- Based on the above findings, carry out further laboratory-scale work to firm-up operating conditions and process configuration(s).
- Process this type of material on a pilot plant-scale to develop continuous capacity curves for this application.
- Firm-up cost estimates, based on the obtained pilot plant data.
- Further develop the process and mechanical aspects of the pilot plant Centrax Separator and Extractant Recovery equipment to make possible the processing of the very difficult-to-handle solids on a continuous basis together with an essentially complete recovery of liquid product.

3.0 ANALYTICAL PROCEDURE

3.1 Handling of Samples

The 10 samples received were handled in the following manner:

1) Samples were weighed and visually inspected and recorded.

2) Each sample was sub-sampled (60-100g)in order to provide a practical working sample (as outlined in section 3.2).

3) Both original and working samples were blanketed with N_2 and stored in a freezer. This was done to minimize oxidation and aging.

3.2 Sampling

Since all the samples were heterogenous in nature the samples had to be well-mixed in order to take representative aliquots.

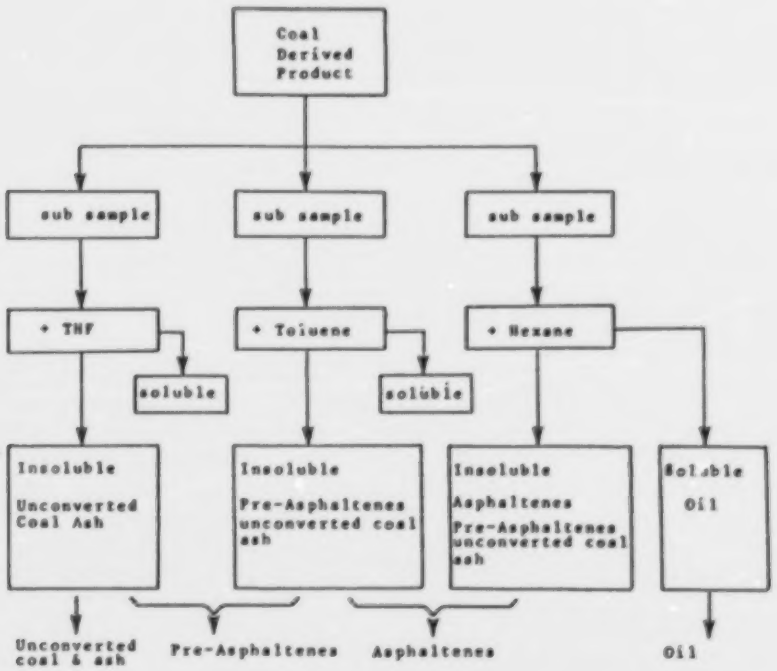
The method employed was dependent on the nature of the sample at room temperature. The highly viscous materials were warmed in a water bath and stirred mechanically prior to sampling. The non-viscous samples had significant amounts of precipitate which were difficult to mix and keep in suspension. This was solved by sampling the product when it was semi-frozen and it formed a type of "slush".

3.3 Analysis

Coal-derived products are considered to consist of solids, pre-asphaltenes, asphaltenes and oils. These are generally characterized by their solubility in different solvents[1]. The use of a solubility classification method is dependent on certain key factors. The main factors are: versatility of use on different materials, extraction of all soluble material, precision and speed of characterization. In this report solids are considered to be that fraction which is insoluble in tetrahydrofuran (THF) and consists of unconverted coal and ash. Preasphaltenes are those that are soluble in THF but insoluble in toluene whereas asphaltenes are soluble in toluene but insoluble in hexane. The hexane-soluble portion is considered to be oil.

As illustrated in Figure 3.1, the classification of a coal-derived product is done by finding its solubility in each solvent and then determining each fraction by difference. Solvent extractions and insoluble collection is performed by vacuum filtration which allows for immediate analysis using solvents of relatively low toxicity and without the need for using the time consuming soxhlet extraction technique. Separate samples are used for each analysis.

Figure 3.1 ANALYSIS SCHEMATIC



For each analysis a sample is weighed in a beaker and dissolved by an excess (40 to 50 times the sampled weight) of the appropriate solvent. Maximum solvent extraction is accomplished by stirring the sample vigorously on a hot plate near the boiling point of the solvent for a minimum of thirty minutes.

The samples are allowed to cool to room temperature and then are filtered under vacuum using a pre-weighed filter. The filters employed (Pall Ultipor) are a membrane type, constructed of Nylon 66 with a pore size of 0.45 microns. The filter cake is washed with an excess amount of solvent and then dried in an oven until constant weight is achieved.

Ash is determined by igniting the THF, toluene and/or hexane insolubles at 925°C for a period of 1 hr. as per ASTM 1553-73 1982. Since the filters are ashless, both the filter and filter cake are ignited.

Simulated distillation has been used here as a method for obtaining boiling point data of the liquid fraction of the hydrocarbon slurries, in addition to vacuum distillation data.

The simulated distillation system used consisted of a Perkin-Elmer Sigma 3 chromatograph with dual FID detectors and a Sigma 10 data acquisition console. The columns used were 61 cm long, 0.32 cm diameter, stainless steel, packed with 10% SP2100 on 60/80 supelco-port.

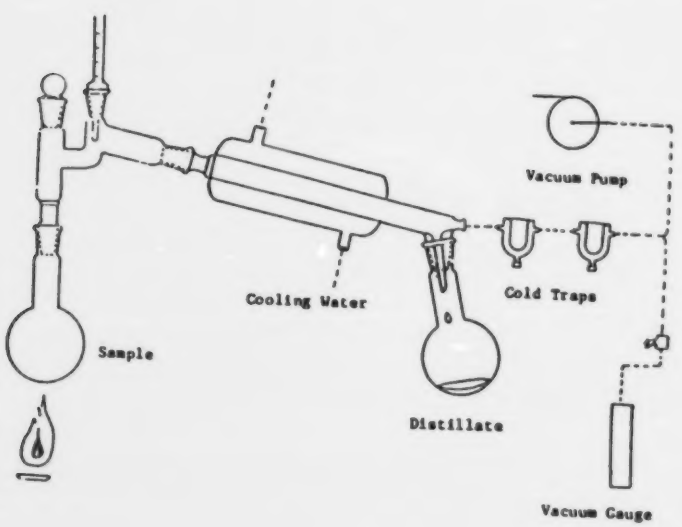
column temperature	- initial	: 60°C
	- final	: 340°C
	- rate	: 8°C/min.
detector temperature		: 350°C
injector temperature		: 350°C
carrier gas		: N_2
sample size		: 0.2 - 1.0 µl
analysis time		: 35 minutes

Calibration was accomplished with a mixture of n-paraffins from C_7 to C_{40} covering the boiling range 60°C to 525°C.

Vacuum distillations were conducted using a system based on the one illustrated in ASTM D 1160-77. The actual system is shown in Figure 3.2.

Figure 3.2

VACUUM DISTILLATION APPARATUS



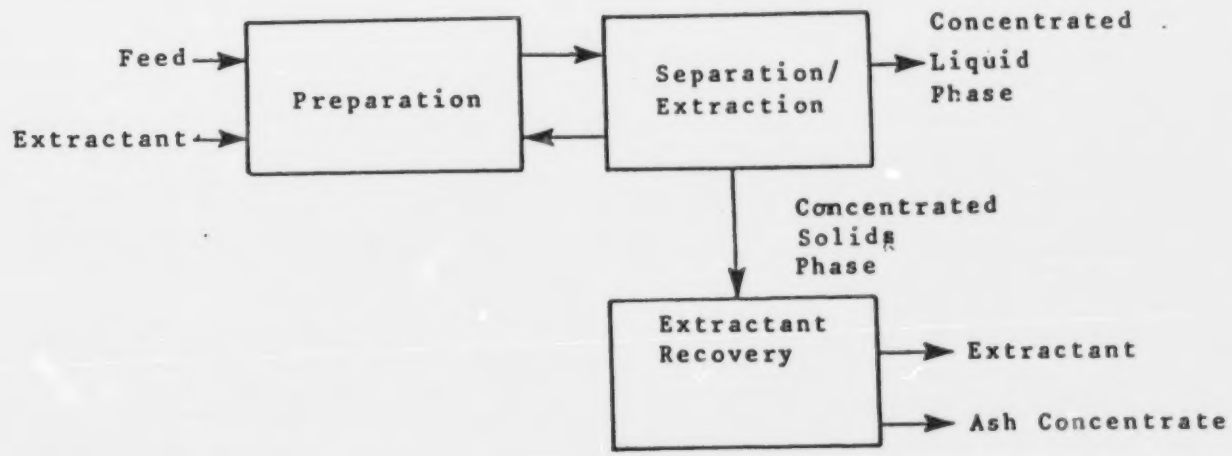
4.0 EXPERIMENTAL PROCEDURE

4.1 Description of Separation/ Extraction Procedure

The separation process is defined as consisting of three stages (as shown schematically in Figure 4.1). These are preparation, separation and extractant recovery. During the preparation step, the starting material (feed and extractant) is heated and mixed. In the separation step the mixture is divided into two streams, an overflow rich in preasphaltenes and asphaltenes and an underflow concentrated in solids.

Additional separations/extractions can be carried out on the underflow if required.

Figure 4.1 SCHEMATIC OF SEPARATION/EXTRACTION PROCEDURE



4.2 Preparation of Feed and Extractant

Generally the feed consisted of a homogeneous portion of the sample to be investigated. This was accomplished as outlined in section 3.2. In some cases, lighter fractions of samples were removed prior to processing . This was accomplished by vacuum evaporation as per section 3.3.

When extractants were used for these experiments they consisted of the distillable fractions of the feed material.

4.3 Preparation

The feed is placed into a centrifuge tube. A predetermined amount of extractant is added and the tube is placed in a preheated oil bath. The oil bath is maintained at the desired temperature and when the mixture melts, the paddle end of a spatula is used to blend and agitate the mixture. It is mixed continuously until the required temperature is reached (10 minutes).

At this point, the mixer is removed and carefully scraped making sure that the removed material falls down into the mixture. This is done not only to limit material losses but to maintain the original sample composition since certain constituents preferentially adhere to the mixer. They are probably preasphaltenes and asphaltenes.

4.4 Separation

The tube is transferred to a modified laboratory centrifuge. The centrifuge is insulated and its temperature is monitored by a thermocouple located inside the bowl. It is preheated during the preparation step and is at the prescribed temperature when the tube is placed in it. During the transfer, care is taken that neither the mixture nor the centrifuge cool down. The centrifuge temperature is achieved and maintained by blowing hot air into the bowl. A preheated counter balance is also transferred. The tube is processed at a selected speed and for a predetermined length of time. Immediately on completion, the top layer is decanted into a receiver before the mixture cools. Care is taken not to remix the two layers during this procedure. The bottom layer remains in the tube and is allowed to cool to room temperature.

This constitutes a single stage separation but if additional separation/extraction is necessary, the concentrated solid phase can be processed one or more times through the procedure outlined previously.

4.5 Extractant Recovery

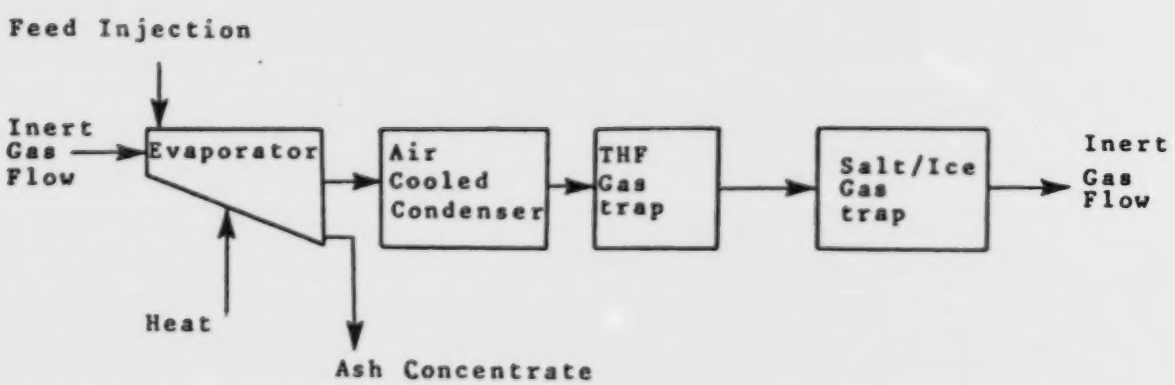
Extractant recovery is facilitated by flash evaporation of distillables from the concentrated solids phase. Flash evaporation is carried out at atmospheric pressure. Evaporated vapours are removed from the high temperature environment almost instantaneously by an inert gas.

The flash evaporation unit is shown schematically in Figure 4.2. It consists of an inclined stainless steel plate enclosed by a housing complete with nitrogen purge, inlet and outlet ports. The plate temperature and evaporator inside temperature are monitored by thermocouples. Condensers and gas traps are connected in series to the exit port. A piston-type injector is used to introduce the concentrated solid phase (CSP)into the unit.

The plate is inclined to the desired angle and heated. The angle is such that it allows the feed to flow in a thin layer down the entire length of the plate, where the oils are evaporated and swept away by the nitrogen purge. Too shallow an angle will result in the feed staying en masse below the injection port. Conversely, too steep an angle will result in the CSP rolling down to the bottom of the plate. In both cases there is evidence that distillable material tends to become entrapped in the bulk of the residue where it undergoes thermal degradation. A low temperature will result in a higher residence time thereby increasing the probability of degradation. A higher than required temperature will probably promote thermal cracking. All these conditions are undesirable.

The nitrogen purge carries the distillables through the condensers and into the THF filled gas trap. Most of the oils are collected in the

Figure 4.2 LABORATORY EXTRACTANT RECOVERY SYSTEM



condenser with the remainder dissolving into the THF as the gas passes through.

The oil is recovered by washing the condensers and gas trap with THF. The residue left on the plate is called ash concentrate and is manually scraped off. It is a dull grey, friable and porous solid. A small amount of non-injected material is removed from the injection system by THF washing.

4.6 Counter-Current Separation/Extraction Simulation

The aforementioned separation/extraction experimental procedure can be extended to simulate a counter-current operation.

The process configuration selected, based on an investigation of the effect of the process variables on the separation, consisted of a four-stage extraction/separation operation. It is comprised of three counter-current extraction/separation stages preceeded by a single separation/extraction operation utilizing no extractant.

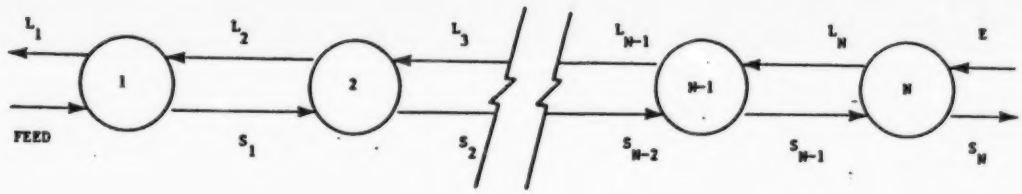
A multi-stage cascade can be utilized as illustrated in Figure 4.3. The stages are numbered in the direction of flow of the solids. The L phase is the liquid that overflows from stage to stage in a direction counter to that of the underflow, dissolving asphaltene and pre-asphaltenes as it goes from stage N to N-1 to N-2..., to stage 1. The extractant concentrated in asphaltenes and pre-asphaltenes overflows from stage 1. The solids phase is the underflow flowing from stage 1 to stage 2..., to stage N and leaves stage N concentrated in solids and lean in asphaltenes and pre-asphaltenes.

Since the extractions/separations were conducted in batch mode, certain difficulties were presented by this nature of operation. In the case of a three-stage process, the simulation of stage 2 required the overflow from stage 3 but in order to simulate stage 3, underflow from stage 2 and overflow from stage 4 was required. Finally, to simulate stage 4, underflow from stage 3 was needed.

This was overcome by simulating the streams L_3, L_4 and E as required and processing the underflow through stages 2 through 4. For this process scheme, stream E was simulated by the use of the hexane soluble fraction of the feed. The streams L_3 and L_4 were made up by using the overflow from stage 1 and diluting with stream E type material to the asphaltene and pre-asphaltene concentration, as defined by the theoretical concentration of these streams. The theoretical value is arrived at by assuming that precipitation does not occur anywhere in the process.

Figure 4.3

SCHEMATIC OF A COUNTER-CURRENT PROCESS CONFIGURATION



5.0 CHARACTERIZATION OF SAMPLES

Ten samples were received on 30 October 1984. The handling and sampling procedures are outlined in sections 3.1 and 3.2. The following were performed to characterize the samples:

1) Visual description, see Table 5.1.

2) Analysis of composition. Each sample was analyzed for oil, asphaltene, preasphaltene, unconverted coal and ash as per section 3.3 and the results are listed in Table 5.1.

3) Simulated Distillations. A simulated distillation of each sample was performed as per section 3.3. Figure 5.1 is a summary of the boiling point distributions for the samples in the form of weight percentages based on these boiling ranges: 0-200°C, 200-300°C, 300-400°C, 400-550°C and 550°C plus solids.

5.1 Discussion

From the examination of the physical properties data compiled in Table 5.1 some observations can be made. Firstly, the samples exhibit a wide boiling range. Secondly, the unconverted coal and ash composition and the ratio of coal to ash varies significantly. In addition, the asphaltene and pre-asphaltene composition are significantly different. Hexane solubles, as measured by the analysis procedure described in section 3.3, and distillables obtained by simulated distillation were comparable for eight of the samples (Table 5.1, and Figure 5.1 respectively). Lastly, the thin non-viscous samples contained considerable amount of precipitate which had settled out.

The boiling range of the samples are in the general range of 130°C to 550°C+ with most having lighter fractions. Some have initial boiling points as low as 70-90°C. This is true with the heavy viscous samples SFCF 250383 and SFCF 150284 though the bulk of the samples were of higher boiling point components. Temperature constraints can be widened by distilling the light fraction and using the heavy fraction as a feed to the separation process.

The values of oils (hexane soluble material) and % distillables are comparable except for samples SFCF 250383 and SFCF 150284 where significantly more oils than distillables were obtained. A closer look at the simulated distillations shows these samples to be comprised

primarily of heavy fractions. It is probable that a certain fraction of these heavies is soluble in hexane but is non-distillable by simulated distillation.

The unconverted coal and ash concentrations cover a wide range. The most highly concentrated materials SFCF 250383 and SFCF 150284 (22 and 20% respectively) are the afforementioned heavy viscous samples. The least concentrated sample contains 3.29% unconverted coal and ash.

The asphaltene and preasphaltene concentrations show a large variation. Effective extraction of these component will necessitate the investigation of several process variables one of which will probably be the use of feed to extractant ratio.

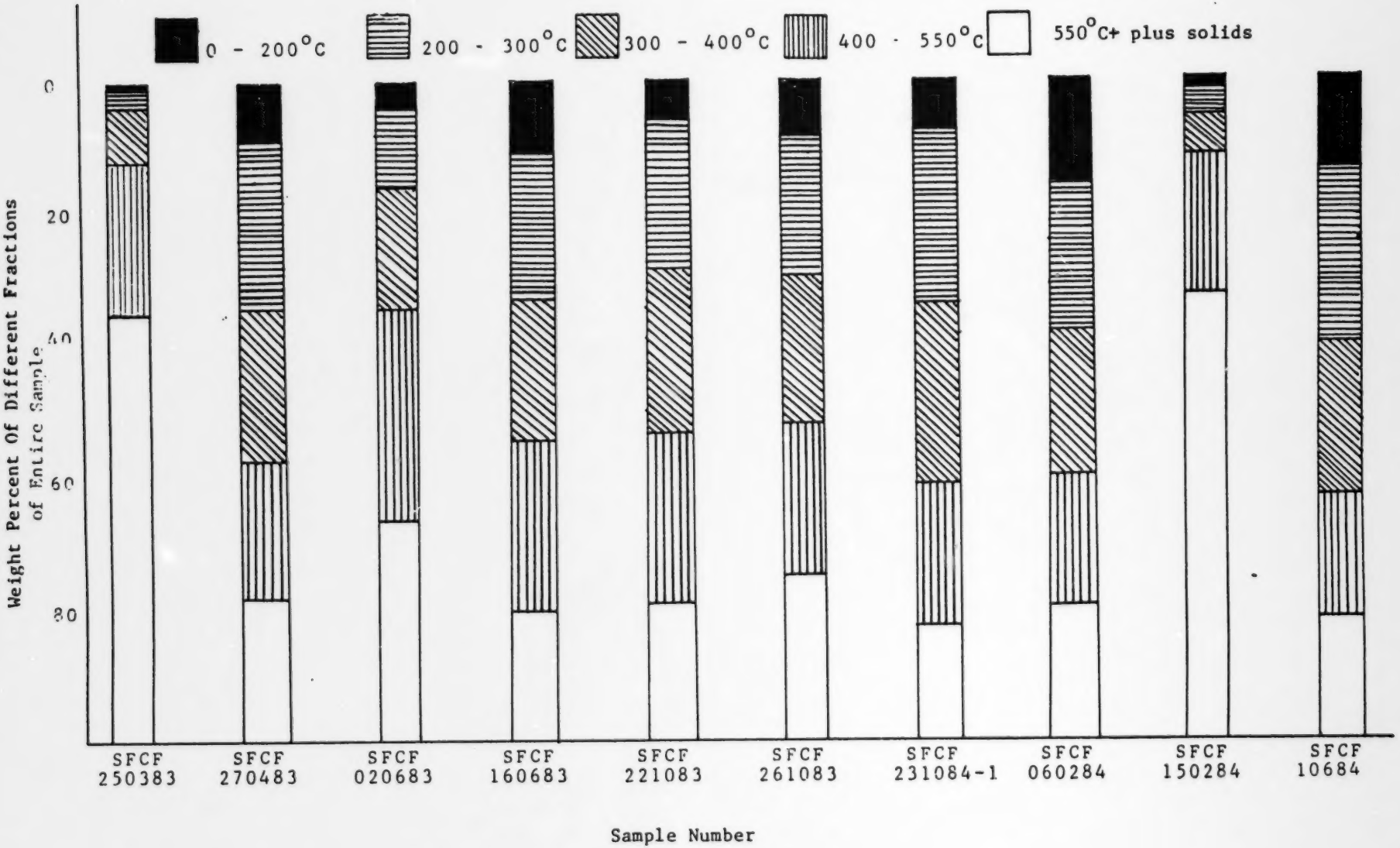
Many of the samples showed significant amounts of precipitation of their asphaltene and pre-asphaltene components at room temperature. This may be due to the significant amounts of light fractions present as shown in the distillation results. In order to recover these precipitated components they must be dissolved into the liquid phase during some stage of the process.

The observed differences in the physical properties of the samples to be used as feed materials to the separation process is expected to result in an inconstancy in separation performance. The most outstanding feature is that the solids are not suspended in a true solution but form a heavy precipitate with the heavier fractions. The recovery of these heavier fractions will necessitate the dissolution of these components prior to the separation step. This will entail either the use of an extractant that dissolves these precipitates and/or increasing the number of stages in order to increase the overall efficiency of the extraction process.

Table 5.1 PHYSICAL PROPTERTIES OF SAMPLES RECEIVED

Name	COMPOSITION					IBP °C	Description room temp.
	Oil	Asph.	Preasph.	U.C.	Ash		
SFCF 250383	61.94 63.71	16.49 14.60	2.54 2.47	15.50 15.89	3.53 3.53	90	heavy viscous fluid
SFCF 270483	82.19	9.68	4.10	1.96	2.07	92	thin fluid with considerable precipitate
SFCF 020683	70.73	12.87	4.62	8.25	3.53	99	viscous fluid
SFCF 160683	84.79	6.94	4.98	1.97	1.32	81	thin fluid with considerable precipitate
SFCF 221083	87.55	5.52	2.21	2.52	2.10	128	thin fluid with considerable precipitate
SFCF 261083	79.35	11.41	3.57	3.03	2.64	85	thin fluid with considerable precipitate
SFCF 231084-1	80.68	9.47	3.77	2.54	3.54	117	thin fluid with considerable precipitate
SFCF 060284	76.66	7.17	2.50	6.40	7.27	70	thin fluid with considerable precipitate
SFCF 150284	64.23 64.80	12.18 11.41	2.08 1.86	14.47 15.53	6.64 6.40	81	heavy viscous fluid
SFCF 016484	78.66	10.57	2.97	5.34	2.46	89	thin fluid with considerable precipitate

Figure 5.1 . DISTRIBUTION OF BOILING POINTS BY SIMULATED DISTILLATION



6.0 PRELIMINARY INVESTIGATIONS

6.1 Ease of Separation

The initial investigation was an evaluation of the separation properties of the sample. This was done by processing the feed without the addition of extractant through the preparation and separation steps as outlined in sections 4.3 and 4.4. Except for process temperature, all were processed at identical conditions of maximum G force and residence time of 5 mins. The processing temperatures were chosen by examining the initial boiling ranges for the sample. Ease of separation evaluations were done by the measurement of solids in the overflow and underflow and comparison with the initial feed material. A visual examination of the underflow (concentrated solids phase, CSP) was made.

The results are listed in Table 6.1. The feed was normalized to 100 units and the underflow and overflow fractions are shown. Also shown are the THF solids and ash components for all three streams. The solids separation efficiency is a measure of the removal of the solids from the overflow. Dryness is a measure of the compactness of the underflow and serves as a gauge of the ability of the solids to displace liquids in the underflow.

Solid separation efficiencies ranged from 95 to 99.9%+. Dryness is simply the solids concentration of the concentrated solids phase and indicates its degree of compactness. The results show the solids concentration ranging from 35% to 48%. The samples which were highly concentrated in solids showed the most compact cake whereas, the least compact was exhibited by the samples with the lowest solids concentration.

The visual appearance of the CSP is an important indicator in the separation performance. Ideally, the CSP should be flat across the top, dull in appearance and compact. A flat surface is an indication of sharp definition between the liquid phase and concentrated solids phase. The lustre of the CSP and its degree of firmness is evidence of its dryness. For the feedstocks tested, all types of concentrated solids phases were apparent.

Table 6.1 RESULTS OF PRELIMINARY SEPARATIONS (Basis, Feed - 100 Units)

SAMPLE	FEED			SEPARATED FRACTIONS: CONCENTRATED LIQUID PHASE			SEPARATED FRACTIONS: CONCENTRATED SOLIDS PHASE			SEPARATION PARAMETERS			DESCRIPTION OF CONCENTRATED SOLIDS PHASE
	Mass	THF.* insol.	Ash	Mass	THF. insol.	Ash	Mass	THF insol.	Ash	TEMP. °C	ASH REMOVAL %	DRYNESS % THF insol.	
SFCF 250383	100	19.22	3.53	53.61	0.014	0.058	46.39	19.09	3.30	180	99.99	41.15	Flat dull gummy tar-like
SFCF 270483	100	4.03	2.07	84.45	0.150	0.121	15.55	5.52	2.08	180	96.28	35.50	Flat shiny hard granular
SFCF 020683	100	11.78	3.53	67.05	0.018	0.074	32.95	12.36	3.76	180	99.99	37.51	Flat shiny gummy granular
SFCF 160683	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Flat shiny hard
SFCF 221083	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Flat dull
SFCF 261083	100	5.67	2.64	80.66	0.27	0.07	19.34	6.83	2.56	140	95.24	35.31	Flat shiny loose granular
SFCF 230184-1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Flat dull
SFCF 060284	100	13.67	7.27	71.71	0.076	0.032	28.29	13.02	7.19	140	99.44	46.02	Flat dull
SFCF 150284	100	21.93	6.40	52.78	0.763	0.033	47.32	22.54	6.09	180	96.52	47.63	Flat shiny hard granular
SFCF 010684	100	7.80	2.46	82.71	0.023	0.047	17.29	6.43	2.22	180	99.70	37.19	Flat shiny hard granular

* THF insoluble material consist of unconverted coal plus ash.

7.0 PROCESS VARIABLES

A total of 25 experiments were conducted on samples SFCF 250383, SFCF 261083, SFCF 150284, SFCF160684, SFCF 020683, SFCF 150284 and SFCF 010684 to investigate ash removal and extraction parameters.

The dependent variables include:

- percent ash in the liquid product (concentrated liquid phase CLP)
- percent asphaltenes and pre-asphaltenes precipitation
- percent asphaltene and pre-asphaltene concentration in concentrated solids phase

The investigated independent variables were:

- temperature
- amount of extractant
- type of extractant

The parameter % ash in liquid product is an evaluation of the ash separation efficiency of the process. The extraction performance is derived from the measurements of the asphaltenes and pre-asphaltene fractions in the CSP and CLP expressed on a solids free basis.

The last stage of the separation/extraction process was the recovery of the distillables/extractant from the concentrated solids phase. The process streams from this operation consisted of the ash concentrate (AC), distillable liquids and gaseous products.

The optimum conditions should yield maximum insoluble material (organic and ash) in the AC, maximum recovery of liquids from the feed and minimal gaseous product generation.

To evaluate the performance of this stage, the following parameters were chosen:

- Liquid Recovery is the amount of interstitial liquids (oil, asphaltenes and pre-asphaltenes) in the concentrated solids phase that is evaporated and recovered,

- Coked Material is the amount of interstitial liquids in the concentrated solids phase that is converted into THF insoluble organic material,

- Gas Production is the amount of interstitial liquid in the concentrated solids phase that is converted into gaseous non-condensible material.

7.1 Separation/Extraction

7.1.1 Ash Separation

Illustrated in Figure 7.1 are the results of the ash separation investigation where the % ash CLP is plotted versus the % cumulative extractant.

The variable % ash is the ash concentration in the concentrated liquid phase. The parameter % cumulative extractant is the amount of extractant added to the feed. For a single stage operation it is simply the weight percentage of extractant added initially to the feed. For a multi-stage operation it is the extractant that remains in the concentrated solids phase from previous stages as part of the interstitial liquid plus the extractant added to the concentrated solids phase at that stage. In this case, the CSP becomes the "feed" for that stage.

Ash concentrations of less than 0.3% were achieved in the CLP in all the experiments with the majority of separations yielding concentrations of less than 0.03%. Generally, the % ash in the CLP separated from re-slurried concentrated solids phases in a multi-stage operation decreases to zero percent (see Appendix 2, experiments 13B, 13C, 13E, 3B and 4D). The effect of temperature on % ash is not well defined. Some of the higher ash concentrations occurred at lower temperatures (denoted by the points ▼and ★). However, the temperature effect might well be confounded with the effect of the type of extractant as discussed in the next paragraph. In addition, the number of experiments are rather few in number and do not allow for a definite conclusion as to the effect of temperature.

The type of extractants used appear to have a significant effect. Experiments number 8 and 10 were conducted at 140°C and a feed:extractant ratio of 1:0.05. SFCF 261083 was used as feed for these two experiments, while the used extractants were the 180°C + fraction of the distillate of SFCF 261083, (experiment #10), and the 85°C +distillate of same (experiment #8). A ten fold increase in % ash in the CLP was evident when the latter extractant was used as shown in Figure 7.1. This is a tentative observation since it is based on the data from only two experiments.

The main point to note is:

- ash concentrations of as low as zero - 0.03% can be achieved in the liquid product.

7.1.2 Precipitation

The amounts of asphaltene and pre-asphaltene precipitated are shown in Figure 7.2. The quantity percent precipitated asphaltene and pre-asphaltene is the fraction of these components precipitated from the concentrated liquid phase. The effects of temperature, type of extractant, amount of extractant and type of feed were investigated.

Figure 7.1 ASH CONCENTRATION OF SEPARATED CONCENTRATED LIQUID PHASE

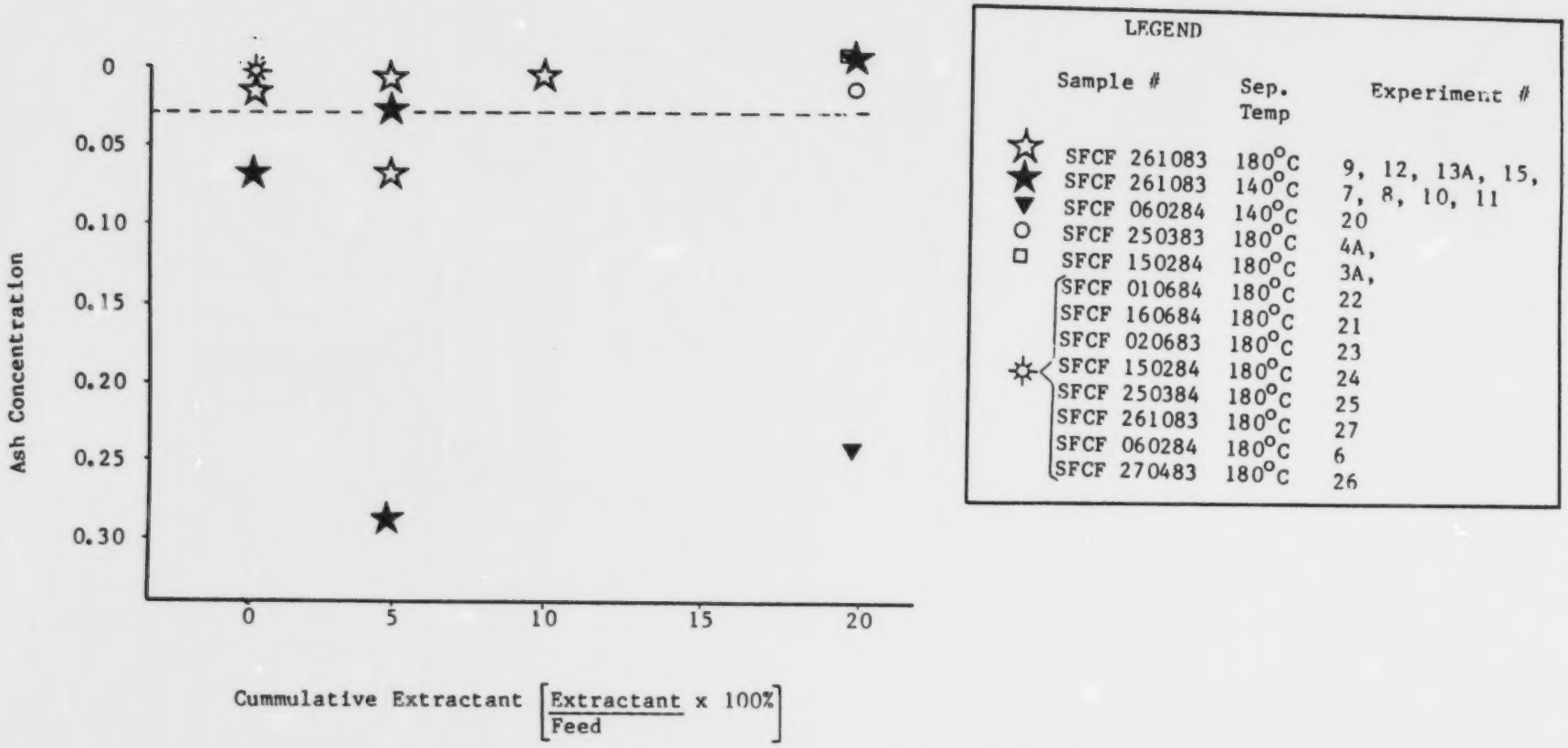
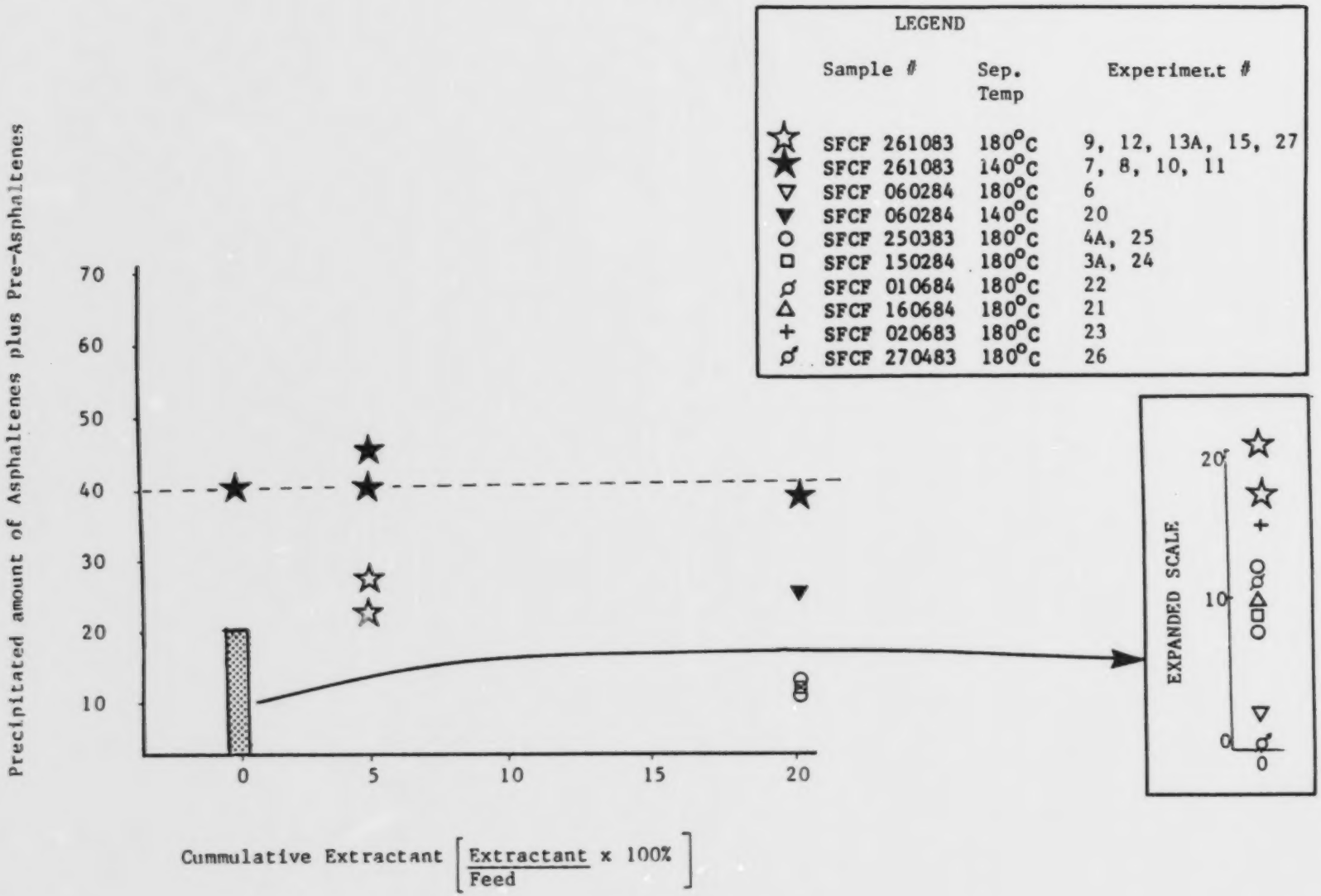


Figure 7.2 PRECIPITATION OF ASPHALTENES AND PRE-ASPHALTENES FROM CONCENTRATED LIQUID PHASE



At 140°C there was no appreciable change in precipitation for the range 0 - 20% extractant. Generally, less precipitation was apparent at the higher temperature studied.

In order to minimize precipitation, the feed (SFCF 261083) was separated into a 85°C - 180°C and 180°C+ fraction and separation/extractions were performed on the 180°C+ portion using as extractant the 180°C+ fraction of the distillate of the feed. This resulted in:

- reduction in percent precipitation by approximately 40 -50% at extractant levels of zero to twenty percent.

The effect of extractant type was investigated using two extractants at identical process conditions. Sample SFCF 261083 was processed using the 85°C+ and 180°C+ distillates using a feed:extractant ratio of 1:.05 at a temperature of 140°C. These experiments are denoted by ★ in Figure 7.2 at levels of 5% cummulative extractant. The difference in % precipitation was marginal and is within the variation exhibited by repeat experiments. These repeat experiments are denoted by ☆ also on Figure 7.2 and at extractant levels of 5%.

The separation/extractions performed on the heavy higher boiling points materials, samples SFCF 250383 and SFCF 150284, exhibited considerably lower preasphaltene and asphaltene precipitation at extractant levels of 0 - 20%.

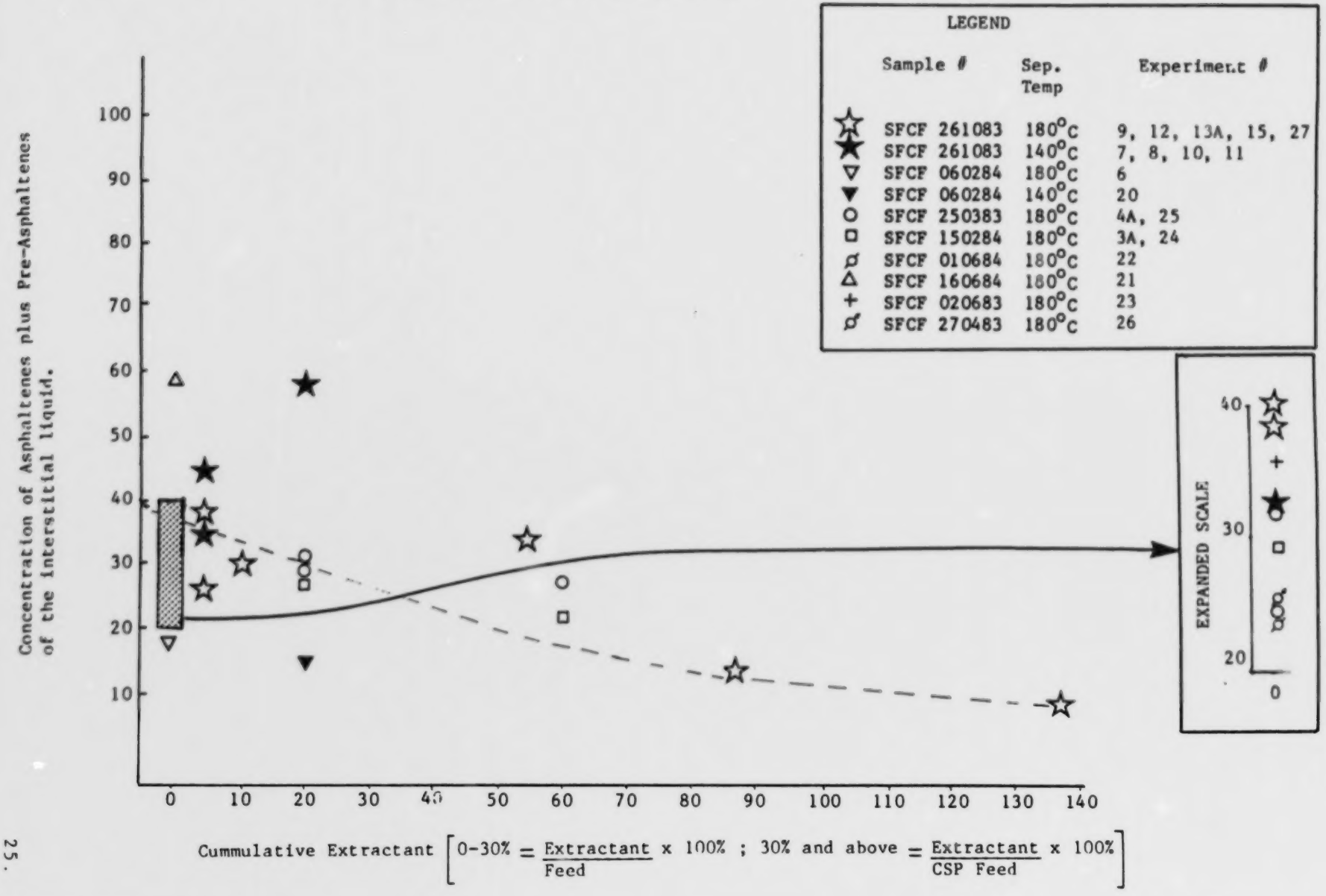
Although, the relative amount of precipitated asphaltenes and pre-asphaltenes in the interstitial liquid of the CSP increased in subsequent stages of multi-stage separations, the actual concentration of these components in the interstitial liquid was reduced in each stage due to the effect of re-dilution and re-compaction of the CSP. (Appendix 2, experiments 3B, 4D, 13B, 13C, and 13E). This is discussed in detail in the next sub-section.

7.1.3 Asphaltene and Pre-asphaltene Content of CSP

The % asphaltene and pre-asphaltene concentration of the CSP is based on a solids free basis and is the sum of those components that are precipitated and those that are part of the homogeneous liquid phase. This is another measure of precipitation during the separation/extraction process. Precipitation reduces the efficiency of the extraction step and results in the loss of effectiveness of the extractant recovery stage as discussed in section 7.3.1.

The asphaltene and preasphaltene concentrations of the CSP are shown in Figure 7.3 as a function of % cumulative extractant. Generally, the % asphaltenes and pre-asphaltenes of the CSP decreases with the amount of extractant added. This is due to dilution of the asphaltenes and pre-asphaltenes by the extractant in the liquid phase. This effect is also apparent in the successive extractions simulating a multi-stage extraction where, after four stages the % asphaltene and pre-asphaltene is reduced to 8.99% from a first stage concentration of 29.24% by the repeated redispersion and compaction of the solids.

Figure 7.3 REDUCTION OF ASPHALTENE AND PRE-ASPHALTENE CONCENTRATION OF THE CONCENTRATED SOLIDS PHASE AS A RESULT OF REPEATED SEPARATION AND DILUTION WITH EXTRACTANT


LEGEND
Sample # Sep. Temp Experiment #
SFCF 261083 180°C 9, 12, 13A, 15, 27
SFCF 261083 140°C 7, 8, 10, 11
SFCF 060284 180°C 6
SFCF 060284 140°C 20
SFCF 250383 180°C 4A, 25
SFCF 150284 180°C 3A, 24
SFCF 010684 180°C 22
SFCF 160684 180°C 21
SFCF 020683 180°C 23
SFCF 270483 180°C 26
EXPANDED SCALE
Concentration of Asphaltenes plus Pre-Asphaltenes of the Interstitial Liquid.
Cummulative Extractant [0-30% = Extractant / Feed x 100% ; 30% and above = Extractant / CSP Feed x 100%]

7.1.4 Dryness of Concentrated Solids Phase

The compactness of the concentrated solids phase is measured by its solids concentration. These values are plotted in Figure 7.4 as a function of % cummulative extractant. First stage values of between 35-50% were achieved. Processing temperature increases from 140°C to 180°C probably does not affect the % drynesss. Also, the type of extractant appears not to have an effect on % dryness.

In the simulation of the multi-stage cross-current extraction (4 stages) the CSP solids concentration increased from 40% to a maximum of 45%. No increase was apparent in the last two stages.

7.2 Multi-stage Counter-current Separation/Extractions

The slurry samples were processed through a multi-stage counter-current process. This type of configuration more accurately simulates a possible scaled-up industrial process. Material flow diagrams were developed for eight of the ten slurry samples. The remaining two samples had insufficient amounts remaining after the preliminary investigation to conduct proper simulations.

The process conditions and arrangements were chosen based on the results of the preliminary investigations (experiments 3 - 18) as outlined in section 7.0.

The configuration consists of a four stage separation/extraction process. In stage 1, the feed is processed without the use of extractant. The overflow from this stage CLP1 is the primary liquid product stream rich in pre-asphaltenes and asphaltenes and ash-free. The underflow will be the feed to stage 2. The subsequent 3 stages are in a counter-current configuration using as extractant the liquid recovered from the recovery stage. The secondary liquid product stream CLP2 is the overflow from stage 2. The concentrated solids phase from stage 4 serves as feed to the recovery unit.

Prior to processing, the feed underwent a vacuum evaporation to remove the IBP-280°C fraction.

As discussed in section 7.1.2 most of the samples contained considerable amounts of precipitated components which accentuate the need for recovery of these constituents. Hence, the first separation/extraction stage was conducted without the addition of extractant.

The reduction in precipitation of asphaltenes and pre-asphaltenes witnessed when the IBP-180°C fraction was removed was an important consideration in the decision to remove a light boiling fraction prior to the first separation/extraction stage. The choice of fraction to

be removed is dependent on the physical properties of each individual slurry but the optimization of this value is beyond the scope of this study. For comparison purposes the IBP-280°C fraction was removed for all samples investigated.

The operating conditions are listed in Appendix 1 (experiments 20-27).

Although the majority of the asphaltenes and pre-asphaltenes are expected to be recovered in stage number one, the underflow from this stage will still contain significant amounts of these components. The multi-stage counter-current extraction/separation process, utilizing the material collected during the recovery stage as an extractant, is expected to recover these asphaltenes and pre-asphaltenes and should result in a higher liquid product yield since these components will not be recovered during the extractant recovery stage as outlined in section 7.3.1.

The effectiveness of the counter-current separation/extraction process can be measured by the % asphaltene and pre-asphaltene recovered. This variable is defined as follows:

$$\% \text{ recovered} = \frac{(A + PA)\text{Feed} - (A + PA)\text{CSP4}}{(A + PA)\text{Feed}}$$

The resultant asphaltene and pre-asphaltene recoveries achieved by the multi-stage process are summarized in Table 7.1. Also shown are the actual recoveries after stage 1 and theoretical recoveries at both stages 1 and 4.

A wide range of recoveries was apparent. Recoveries of 69 to 95% were achieved. This variance might be due to the difference in the physical properties of the original samples as noted in section 5.1. The operating conditions were constant for all samples.

The highest recoveries were achieved on samples SFCF 270483 and SFCF 160683 which contained the least amount of unconverted coal and ash. When the degree of compaction (% dryness) is constant, low solids content will result in smaller concentrated solid phases. As a consequence, interstitial liquid (oil, asphaltene and pre-asphaltene solutions) on a weight basis, is minimized in the solids phase. Therefore, on a weight basis, a small fraction of the original asphaltenes and pre-asphaltenes would be in the CSP.

The poorest recovery was evident when processing sample SFCF 250383 which posessed not only the highest solids content but also had the largest concentration of asphaltenes and pre-asphaltenes. Converse to the previous situation, these two conditions should, on a weight basis, yield a large CSP where the amount of interstitial liquid is maximized and will contain significant amounts of pre-asphaltenes and

Table 7.1 ASPHALTENE AND PRE-ASPHALTENE RECOVERY

Sample	SUM OF SINGLE-STAGE AND THREE STAGE COUNTER-CURRENT SEPARATION/EXTRACTION		SINGLE-STAGE SEPARATION/EXTRACTION	
	% Recovered Stage 4 actual	% Recovered Stage 4 theoretical	% Recovered after stage 1 actual	% Recovered after stage 1 theoretical
SFCF 250383	69.0	91.4	61.5	65.5
SFCF 270483	93.4	98.4	86.8	90.9
SFCF 020683	77.2	94.2	59.7	76.0
SFCF 160683	95.4	98.5	76.7	94.6
SFCF 221083	-	-	-	-
SFCF 261083	80.5	97.4	76.0	90.3
SFCF 231084-1	-	-	-	-
SFCF 060284	92.8	93.8	73.2	75.2
SFCF 150284	87.3	92.9	38.1	65.1
SFCF 010684	90.9	97.5	81.8	87.6

asphaltenes. Additional stages would be required to produce recoveries approaching those discussed previously.

The remaining samples having asphaltene and pre-asphaltene unconverted coal and ash concentrations between these extremes achieved intermediate recoveries.

Figures 7.5 and 7.6 are plots of asphaltene and pre-asphaltene recoveries as fractions of feed concentrations of solids and asphaltenes plus pre-asphaltenes.

Recoveries shown in Figure 7.5 are those after stage 1. These were chosen since it is only during this stage that the solids concentration will affect the recoveries. In the subsequent stages the same solids are dispersed by equal amounts of liquid and then recompacted.

In Figure 7.6 the total recoveries are plotted and the trend is such that, as the asphaltene plus pre-asphaltene concentration of the starting material increases, the percent recovery of these components decrease. This is as expected since all samples were processed through an identical four-stage configuration. The more-concentrated samples would require additional stages to maximize recoveries.

Multi-stage separation of samples SFCF 270483, SFCF 160683, SFCF 060284, SFCF 150284 and SFCF 010684 achieved recoveries of 90% or better of the theoretically possible values. For example, the actual recovery for sample number SFCF 270483 is 93.4% (Table 7.1) while the theoretical value is 98.4%; therefore, 93.4/98.4 * 100% = 94.9% which is better than 90% of theoretically possible. To achieve similar results for the remaining samples, optimization of the process is required. These optimizations may include removing a different cut prior to stage 1 and/or increasing the number of stages. Each of the samples must be examined individually in order to optimize these conditions. This optimization is beyond the scope of this project.

7.3 Extractant Recovery

7.3.1 Extractant/Liquid Recovery

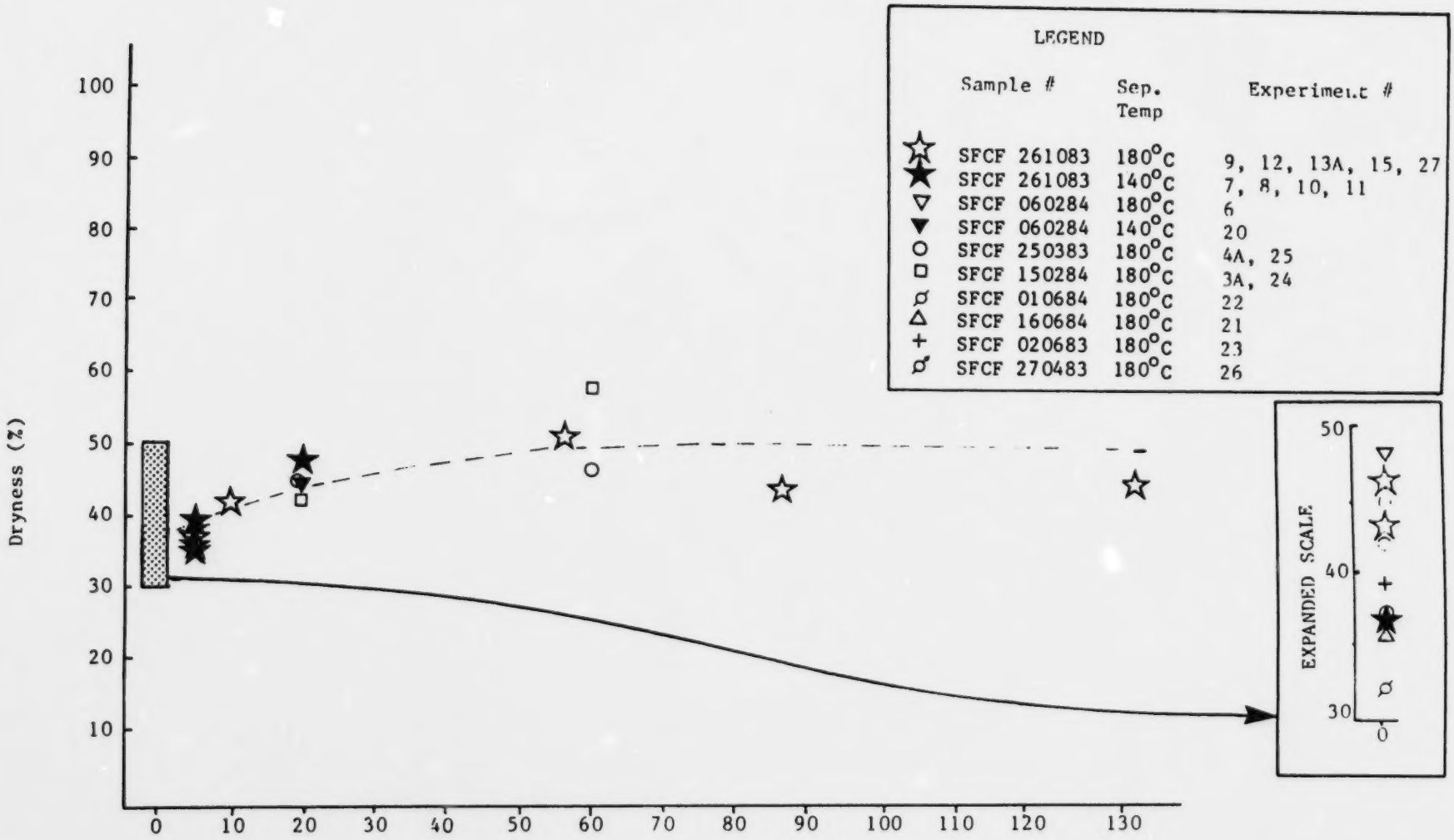
The percent liquid recoveries during the flash evaporation stage are shown in Figure 7.7 as a function of % A & PA in CSP.

A definite trend is seen. As the preasphaltenes and asphaltene content increases, the % liquid recovery decreases. This indicates that :

- there is no recovery of pre-asphaltenes and asphaltenes during the flash evaporation stage.

This is as expected since asphaltenes and pre-asphaltenes (as defined by solubility in hexanes) are considered non-distillable.

Figure 7.4 DRYNESS OF CONCENTRATED SOLIDS PHASE



Cummulative Extractant $\left[0\text{-}30\% = \frac{\text{Extractant}}{\text{Feed}} \times 100\% \; ; \; 30\% \text{ and above} = \frac{\text{Extractant}}{\text{CSP Feed}} \times 100\% \right]$

Figure 7.5 ASPHALTENES PLUS PRE-ASPHALTENES AFTER STAGE 1 AS A FUNCTION OF SOLIDS CONCENTRATION TO STAGE 1

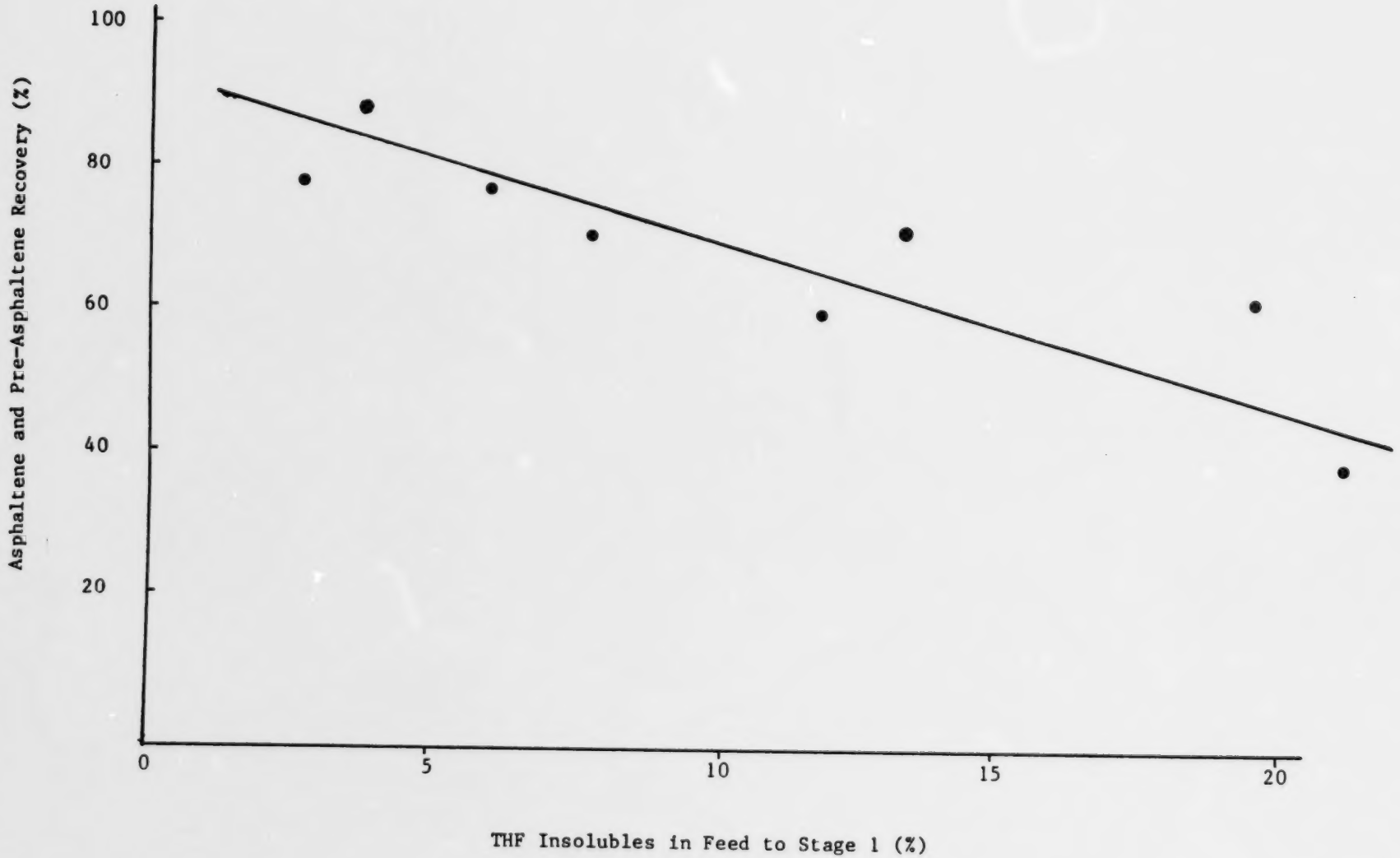
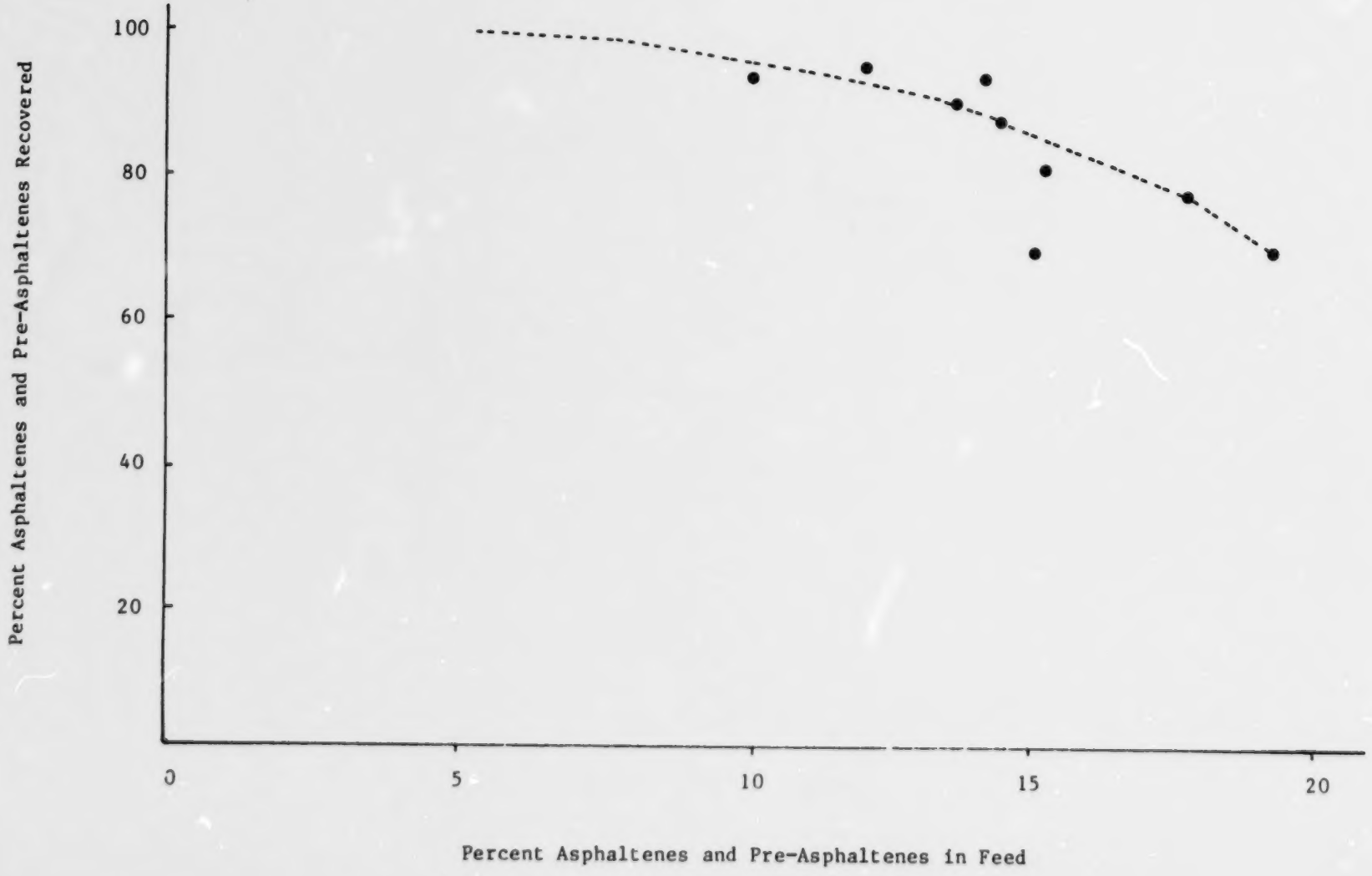


Figure 7.6 ASPHALTENES PLUS PRE-ASPHALTENES AFTER STAGE 4 MULTI-STAGE COUNTER-CURRENT SEPARATION/EXTRACTION AS FUNCTION OF FEED COMPOSITION OF PRE-ASPHALTENES AND ASPHALTENES



Temperature seems to have no effect on the liquid recoveries of high asphaltene and pre-asphaltene concentrated material. The high temperature evaporation of low pre-asphaltene and asphaltenes concentrated feed resulted in only a 50% liquid recovery. This is probably due to a damaged thermocouple which caused a much higher temperature operation and may have resulted in thermally cracking a large portion of the oil fraction.

7.3.2 Coked Material

Illustrated in Fig. 7.8 is the concentration of coked material as a function of % A & PA of the CSP. Examination of Figure 7.8 shows that as the amount of asphaltenes and pre-asphaltenes increase, the amount of coked material tends to increase. In addition, it appears that the amount of coked material produced corresponds to the asphaltene and pre-asphaltene concentration of the CSP used as feed. This again indicates that:

- asphaltene and pre-asphaltenes not recovered in the separation/extraction process cannot be recovered in the flash evaporation step but instead are converted into coked material.

7.3.3 Gas Production

A significant amount of gas production is evident at the high temperature flash evaporations as seen in Figure 7.9. These gases include CO, CO_2, CH_4, C_2H_6, C_3, C_4 and H_2S as analyzed by gas chromatography. The general trend seems to be that as the pre-asphaltene and asphaltene content of the feed increases, gas production decreases. The evolution of the organic gases is probably due to the thermal cracking of the liquid organic fraction.

A pair of experiments (16,17) were carried out at lower temperatures (480°C) in order to minimize gas production. Comparisons can be made with experiments 9 and 18 respectively conducted at a higher temperature (550°C) using identical feed. It is seen that:

- gas production at the lower temperature of both the high pre-asphaltene and asphaltene content and low preasphaltene plus asphaltene content material was reduced to 0%.

The high gas production in experiment 18 is due to excessive temperature due to a defective thermocouple.

Figure 7.7 EXTRACTANT/LIQUID RECOVERY FROM CONCENTRATED SOLIDS PHASE

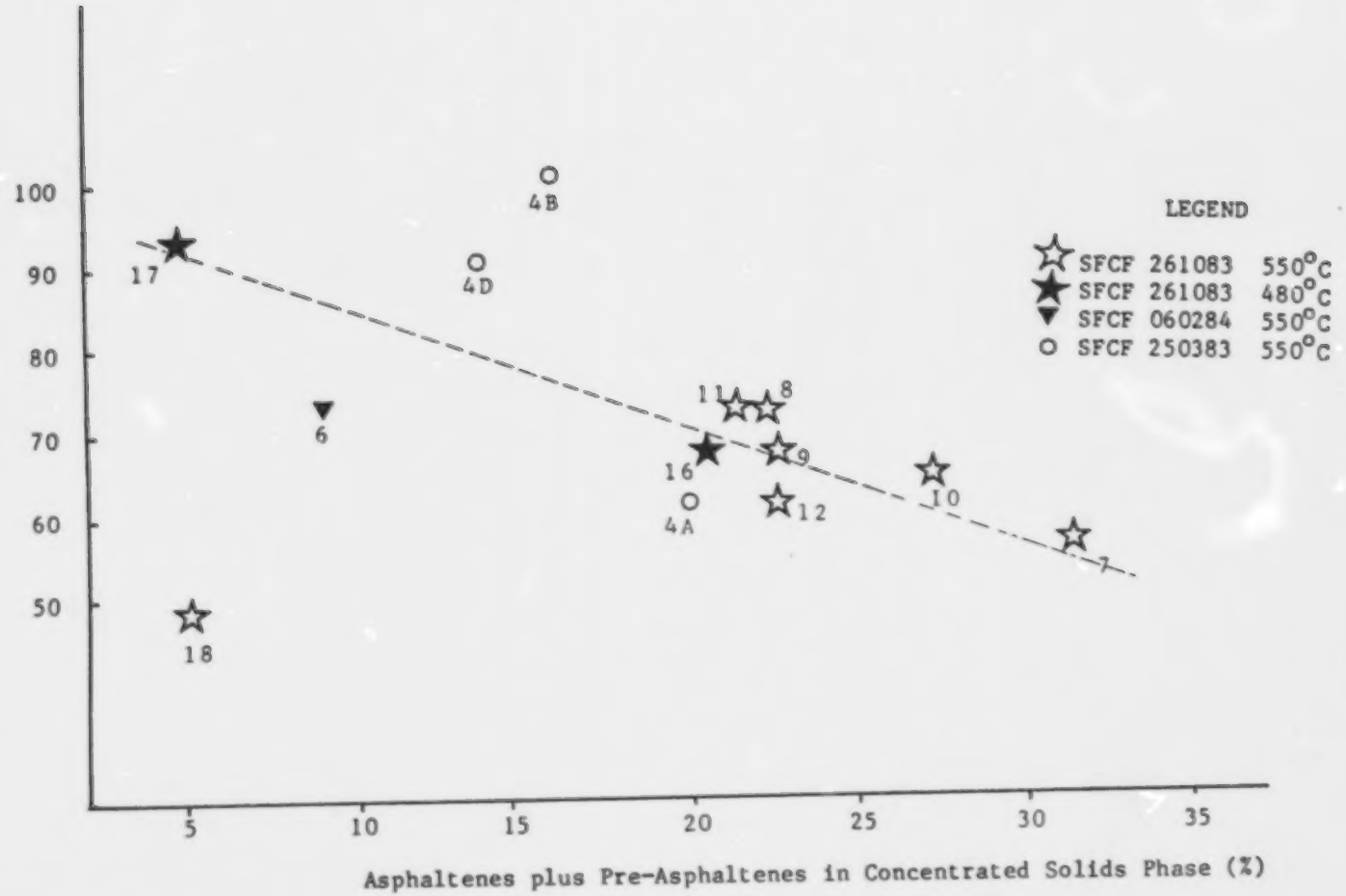
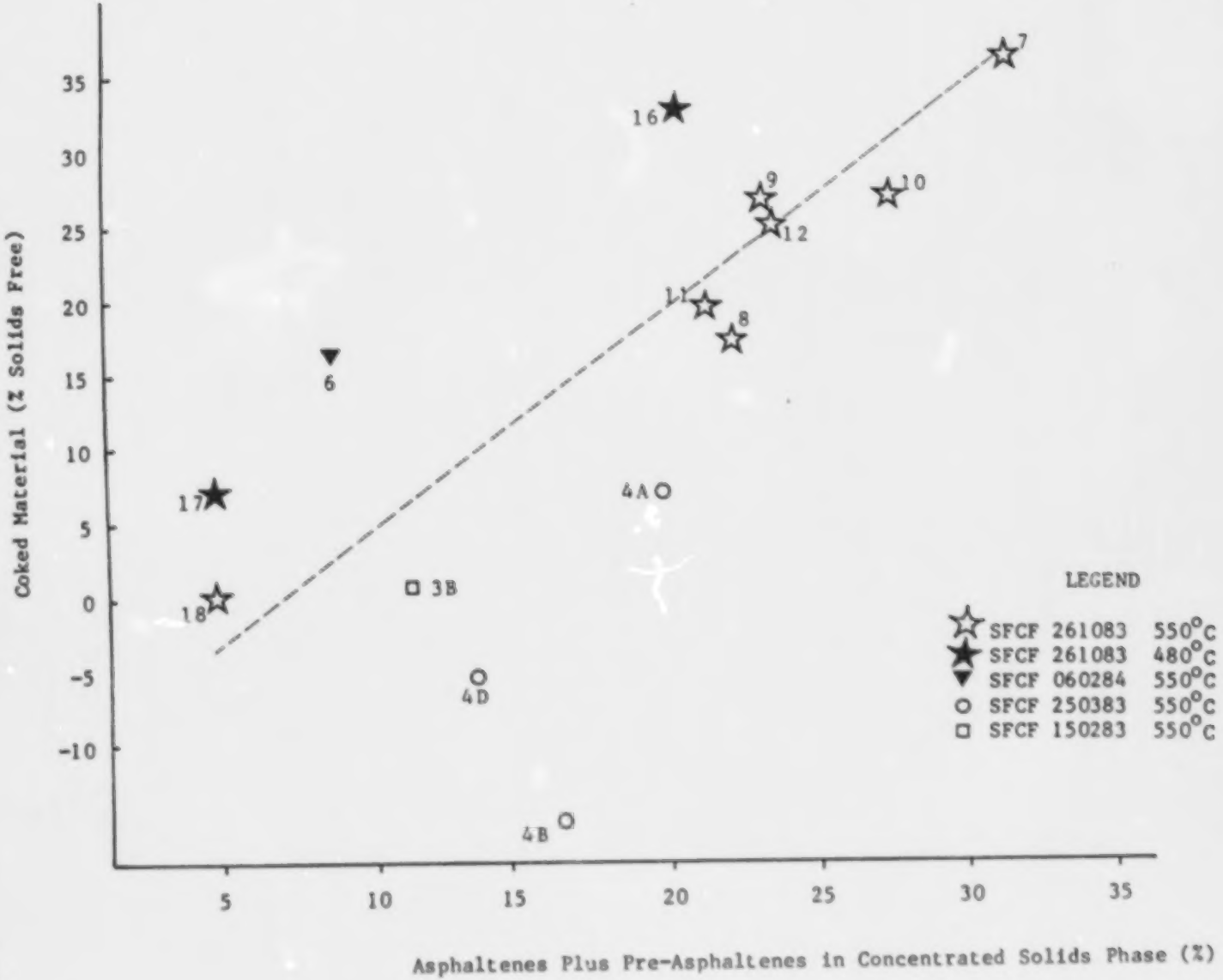


Figure 7.8 AMOUNT OF INTERSTITIAL LIQUIDS OF CONCENTRATED SOLIDS PHASE DEGRADED INTO COKED MATERIAL DURING EXTRACTANT RECOVERY

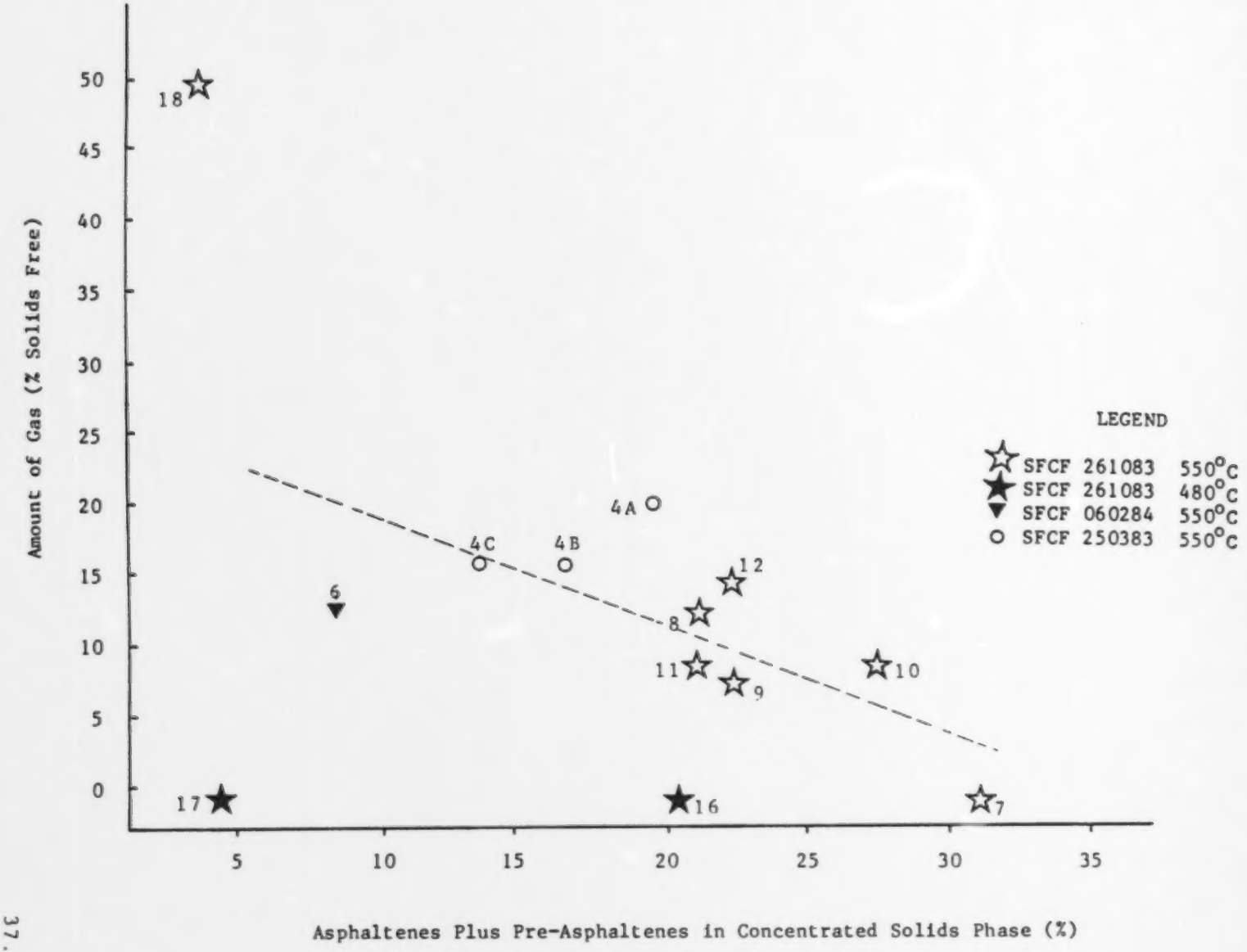


7.3.4 Dryness

Dryness is simply the THF insoluble material contained in the ash concentrate. This insoluble material consists of the unconverted coal and ash in the feed and the coked material produced during the flash evaporation from the non-distillable asphaltene and pre-asphaltenes. From the raw data presented in Appendix 3 it is seen that:

- complete dryness, that is 100% solids was routinely achieved in both the low temperature and high temperature evaporation.

Figure 7.9 AMOUNT OF INTERSTITIAL LIQUIDS OF CONCENTRATED SOLIDS PHASE CRACKED TO GASEOUS PRODUCTS DURING EXTRACTANT RECOVERY



8.0 STABILITY OF PROCESSED MATERIAL

Materials used in this work appear to be unstable. The tendency is for a shift towards THF insoluble materials. Heating the material appears to accelerate this trend.

An investigation of the feed material stability was carried out using the 180°C+ fraction of SFCF 261083. The sample was placed in a 180°C bath and then heated and stirred for 3 hours. An analysis was carried out on both the starting and end materials. The results are listed in Table 8.1

Table 8.1 COMPOSITION OF SLURRY SAMPLES BEFORE AND AFTER BEING HEATED AT 180°C FOR THREE HOURS

	Oil	Asph.	Pre-Asph.	THF Organic Insol.	Ash	CRES organic Insolubles
Starting Material 180°C+ SFCF 261083	74.00	13.61	4.28	4.84	3.27	4.19
End Material 180°C+ SFCF 261083 after 3 hours.	74.36	8.45	6.48	7.46	3.25	2.75

These results show that the hexane soluble portion compositions of both samples are identical. This indicates that this fraction is stable under the 180°C conditions encountered in this test. Asphaltene content diminishes by 38%, whereas the preasphaltene and organic THF insoluble concentrations increase by 51 and 54% respectively. This indicates that there was a definite shift with asphaltenes and preasphaltenes reacting to form larger molecules. The constant ash values show that representative samples were used for analysis and the increase in organic THF insoluble material was the result of the heating procedure. A comparison of organic THF and cresol solids show the same inclination. Numerous cresol analyses conducted previously show that cresol and THF insoluble determinations were comparable on non-aged material.

Further evidence of the instability of these materials can be seen in the analysis of samples of CSP material after processing and then after a period of over two months. These are listed in Table 8.2. The samples were stored in a freezer during this time period.

Table 8.2 COMPOSITION OF AGED AND NON-AGED CONCENTRATED SOLIDS PHASE

SAMPLE	AFTER PROCESSING THF insol.	AFTER 2 MONTHS THF insol.	AFTER 2 MONTHS cresol insol.
CSP 4A	36.36	42.38	36.09
CSP 4B	40.06	46.37	44.07
CSP 4D	43.46	51.26	47.43

It is obvious that there is a definite regression toward the formation of 'quasi' solids (insoluble in THF but soluble in cresol). This is believed to be the result of the linking of asphaltene and pre-asphaltene components in various unknown combinations.

In general, it appears that this material:

- degrades or ages as a function of time and,
- the degradation process is accelerated by exposure to higher temperatures.

9.0 NON-OPTIMIZED MATERIAL BALANCE FLOW DIAGRAMS

Based on the preliminary investigation, a multi-stage process configuration was developed. Experiments were performed to simulate the performance of the different stages of the process in order to investigate the effect of the sequence of process steps on the separation/extraction performance. The results formed the basis from which material balance flow diagrams were developed. These diagrams are shown in Figures 9.1 to 9.8.

A single configuration was used for all eight of the samples. It consisted of four stages, the last three of which operated in a counter-current mode using as extractant, the liquid recovered in the extractant recovery stage. In stage 1, the sample was processed without the use of extractant but prior to processing, a distillable fraction was removed. For this particular process configuration the IBP - 280^{o}C fraction was evaporated.

The simulations were performed at identical operating conditions as summarized in Appendix 1. This was done strictly for comparison purposes in order to evaluate this configuration for the processing the different slurries available. Optimization of the process configuration or operating conditions is beyond the scope of this study but can be carried out on certain samples.

In Figures 9.1 to 9.8, the extractant recovery stage has been omitted since the performance of this stage has been amply demonstrated as illustrated in section 7.3. The feed has been normalized to 100 units and the liquids which were evaporated prior to stage 1 have been included as oil in the stream CLP1. Shown in brackets are theoretical flows based on the assumption that no precipitation occurs during any process step.

The liquid product stream from stage 1 (designated as CLP1 in Figures 9.1 to 9.8) is the major product stream and consists of oil, asphaltenes and pre-asphaltenes but is ash-free and virtually THF insoluble-free. As shown in Figures 9.1 to 9.8, oil concentration ranges from 81 to 94% with asphaltenes and pre-asphaltenes making up the remainder.

It is apparent that precipitation of pre-asphaltenes occurred during stage 1 as seen by examining the theoretical and actual values shown for CSP. The precipitated components are primarily pre-asphaltenes. This conclusion is deduced from an examination of the asphaltene to pre-asphaltene ratio for the feed streams and comparing it to those in CLP1. For all eight cases, the ratio of asphaltene to pre-asphaltene is significantly higher for the liquid phase.

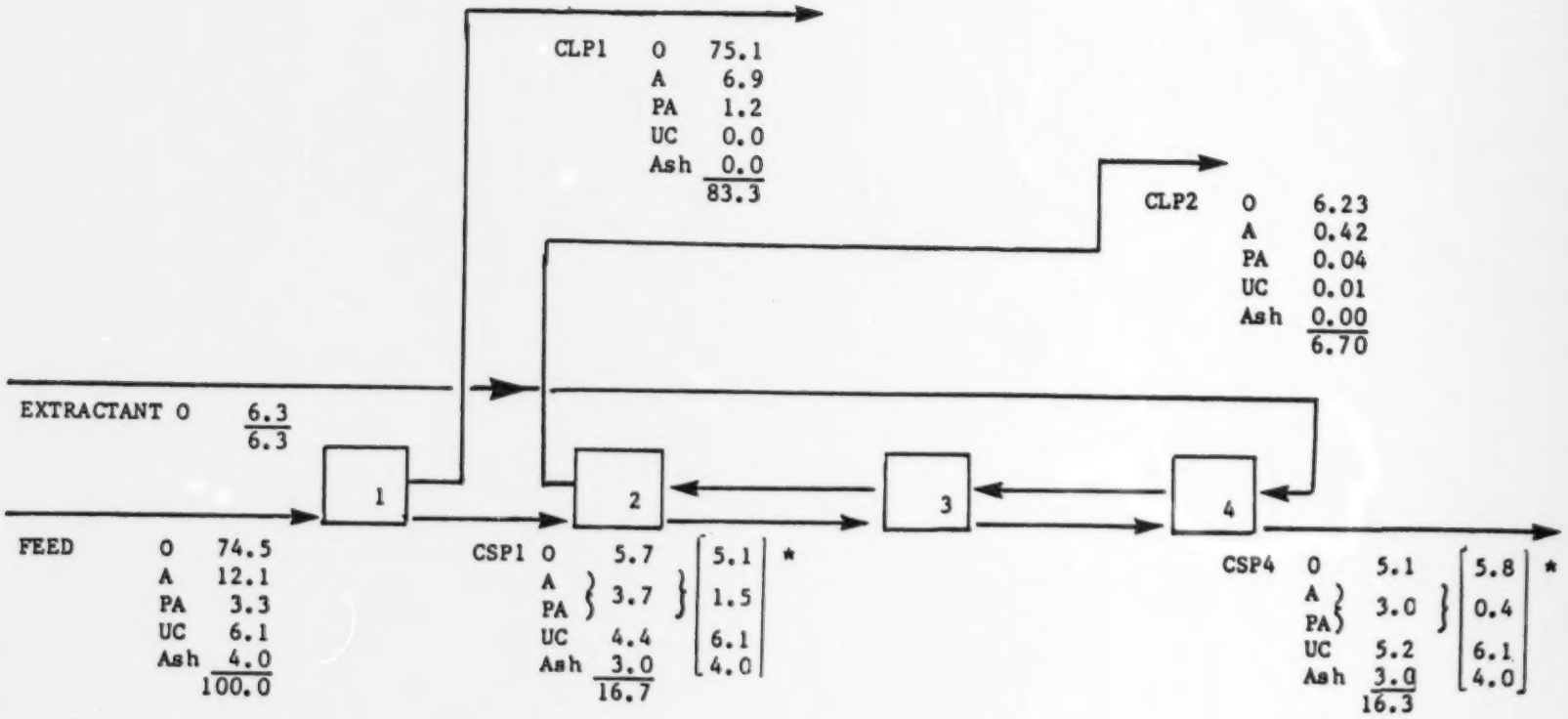
The liquid product stream from stage 2 (CLP2) is a second product stream. It is solids-free and consists of oil and the asphaltenes and pre-asphaltenes extracted during the counter-current section of the process.

The solid phase from stage 4 (CSP4) is the feed to the extractant recovery stage. It consists of the solids (unconverted coal and ash) concentrated between 40 to 45% and the interstitial liquid consisting of oil, asphaltenes and pre-asphaltenes in various compositions. The examination of the theoretical concentrations show that this phase should consist of solids, oil and a small fraction of asphaltenes and pre-asphaltenes. In the case of SFCF 160683, SFCF 270483, SFCF 060284 and SFCF 010684, experimental values obtained, approached theoretical levels. In the cases where significant differences occur it can be attributed to the precipitation of these components which occurs during the processing of the samples through the process steps.

Figure 9.1

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 261083



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

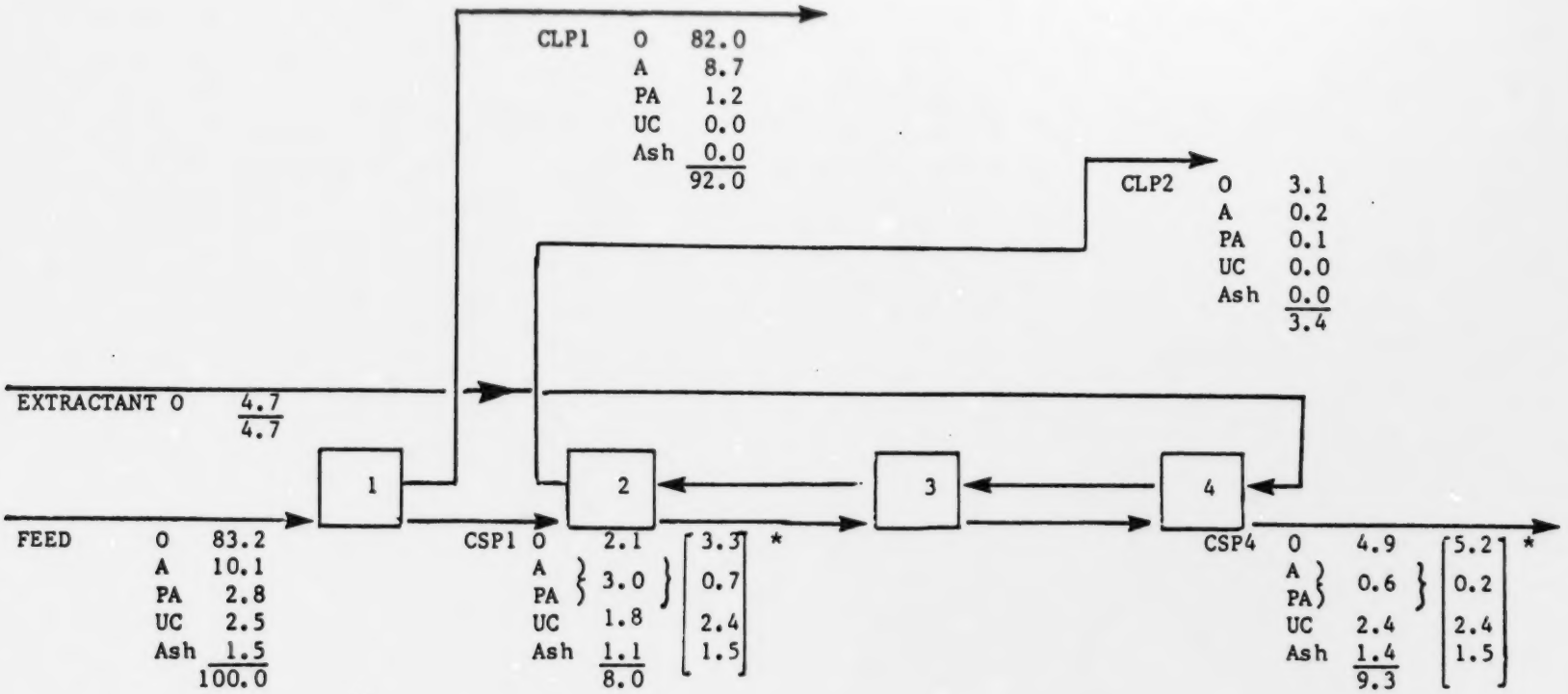
PA Pre-asphaltenes

UC Unconverted coal

Ash Ash

Figure 9.2

MATERIAL BALANCE FLOW DIAGRAMS
SAMPLE SFCF 160683



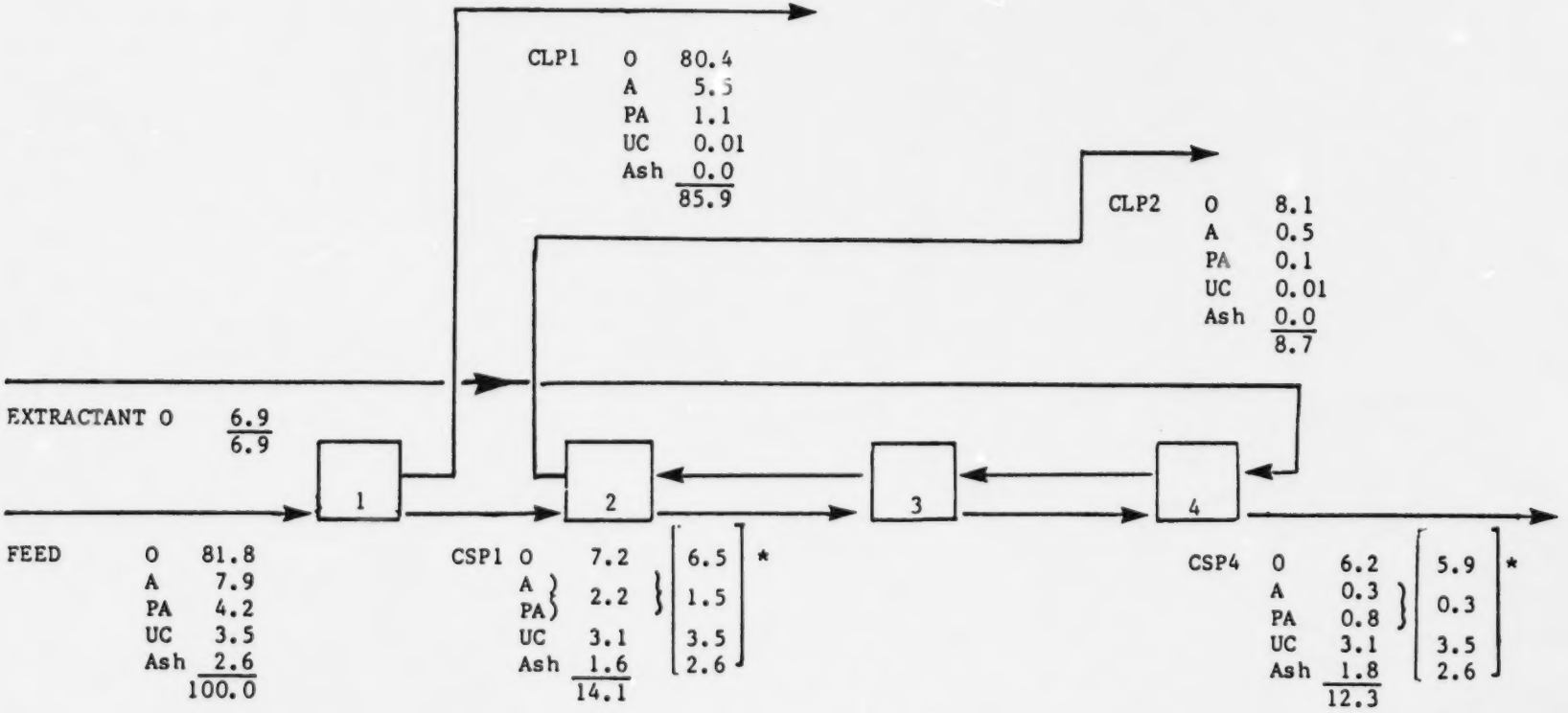
* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil
A Asphaltenes
PA Pre-asphaltenes
UC Unconverted coal
Ash Ash

Figure 9.3

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 010684



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

PA Pre-asphaltenes

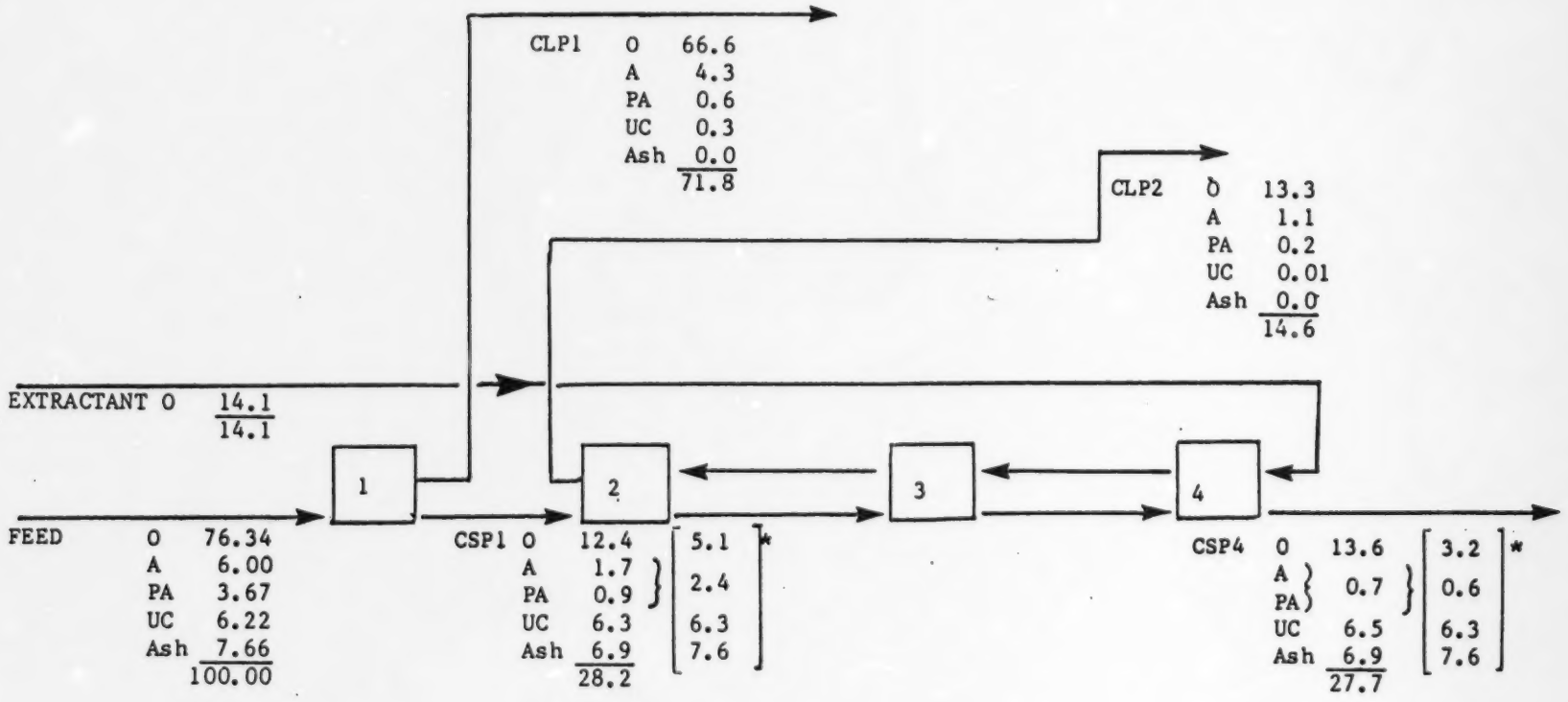
UC Unconverted coal

Ash Ash

Figure 9.4

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 060284



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

PA Pre-asphaltenes

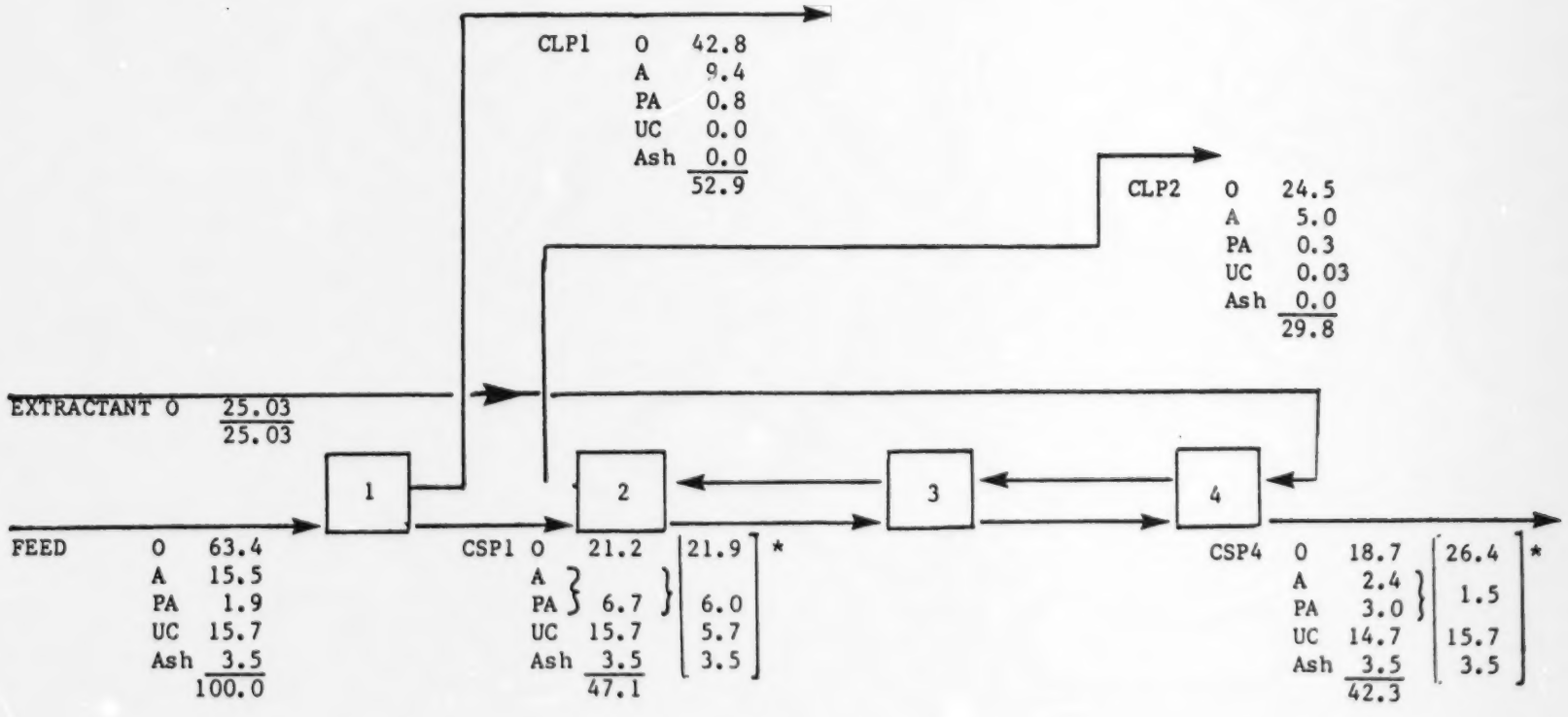
UC Unconverted coal

Ash Ash

Figure 9.5

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 250383



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

PA Pre-asphaltenes

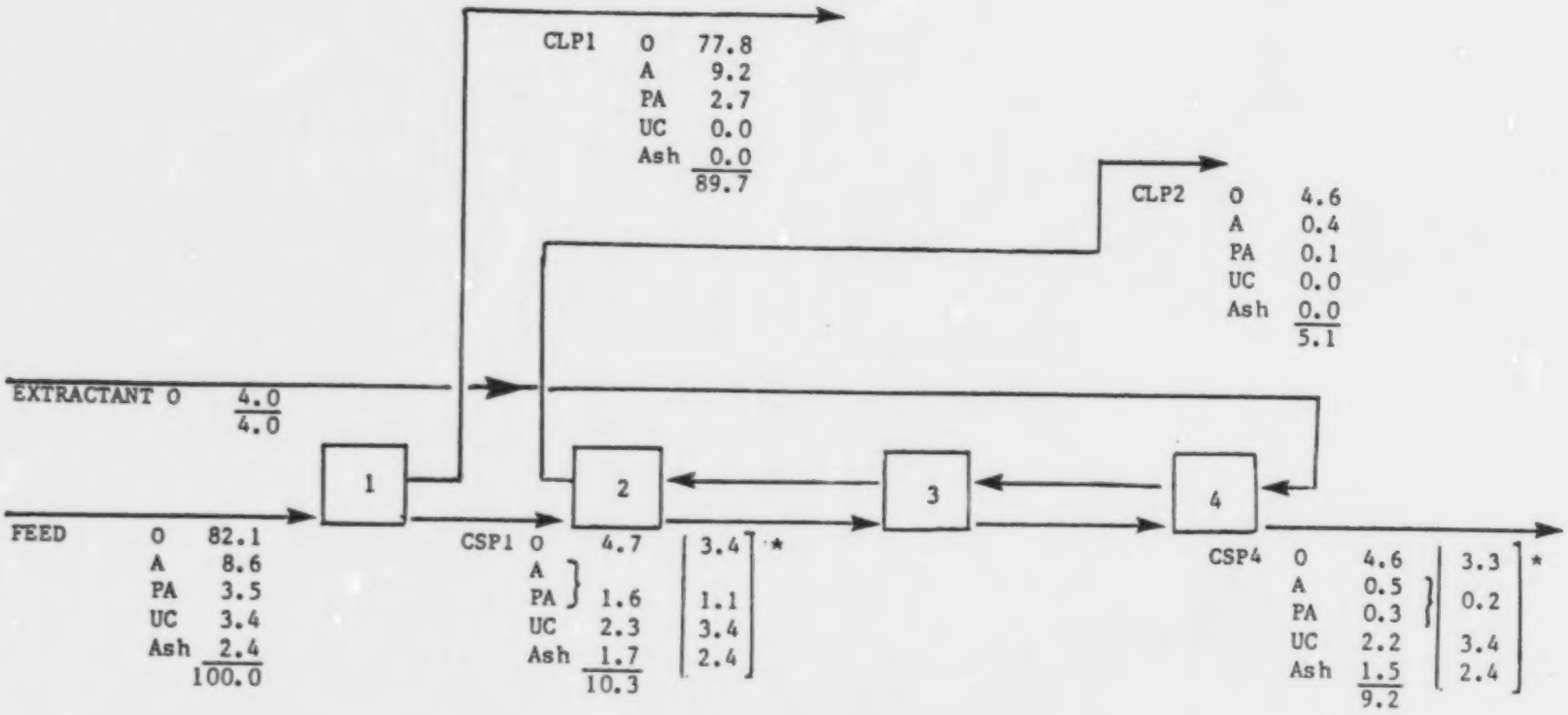
UC Unconverted coal

Ash Ash

Figure 9.6

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 270483



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

PA Pre-asphaltenes

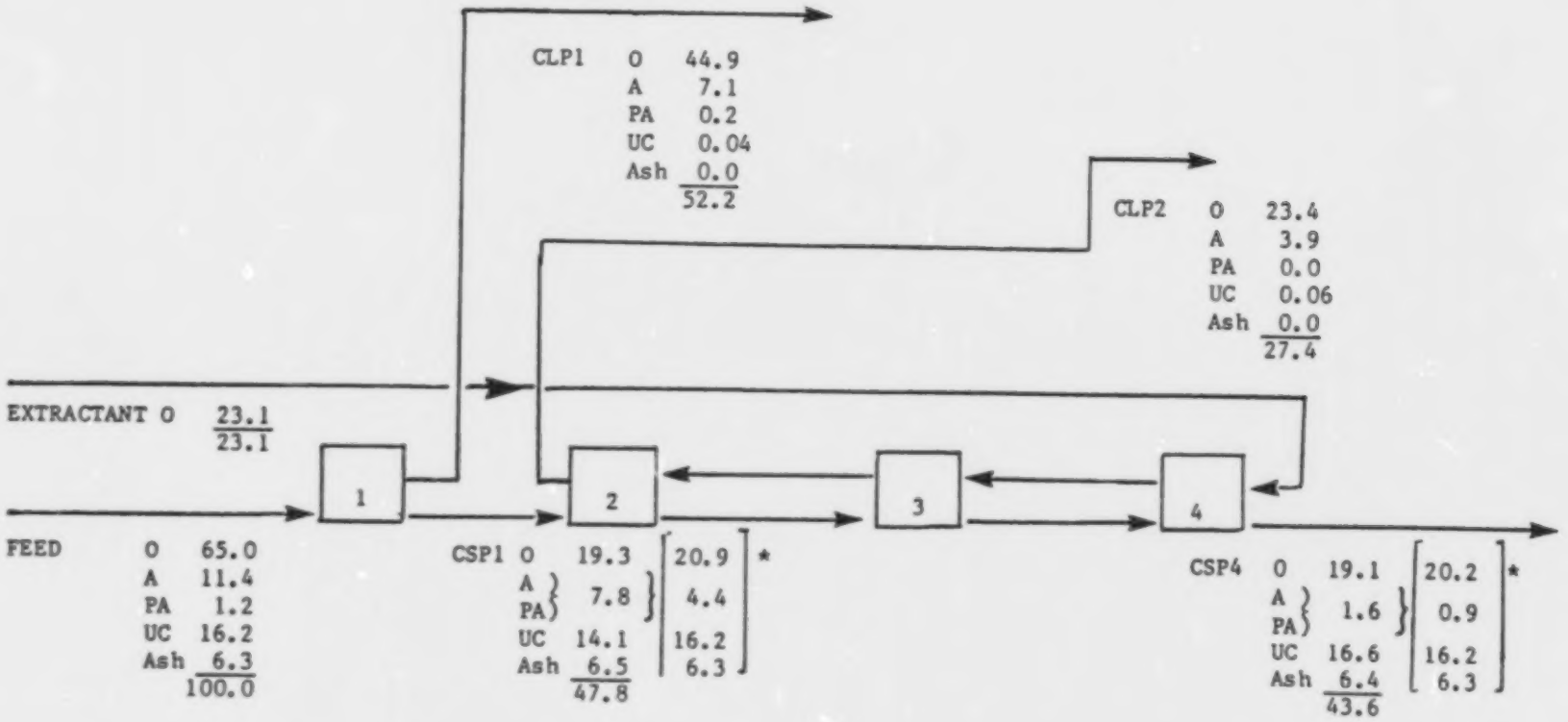
UC Unconverted coal

Ash Ash

Figure 9.7

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 150284



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

PA Pre-asphaltenes

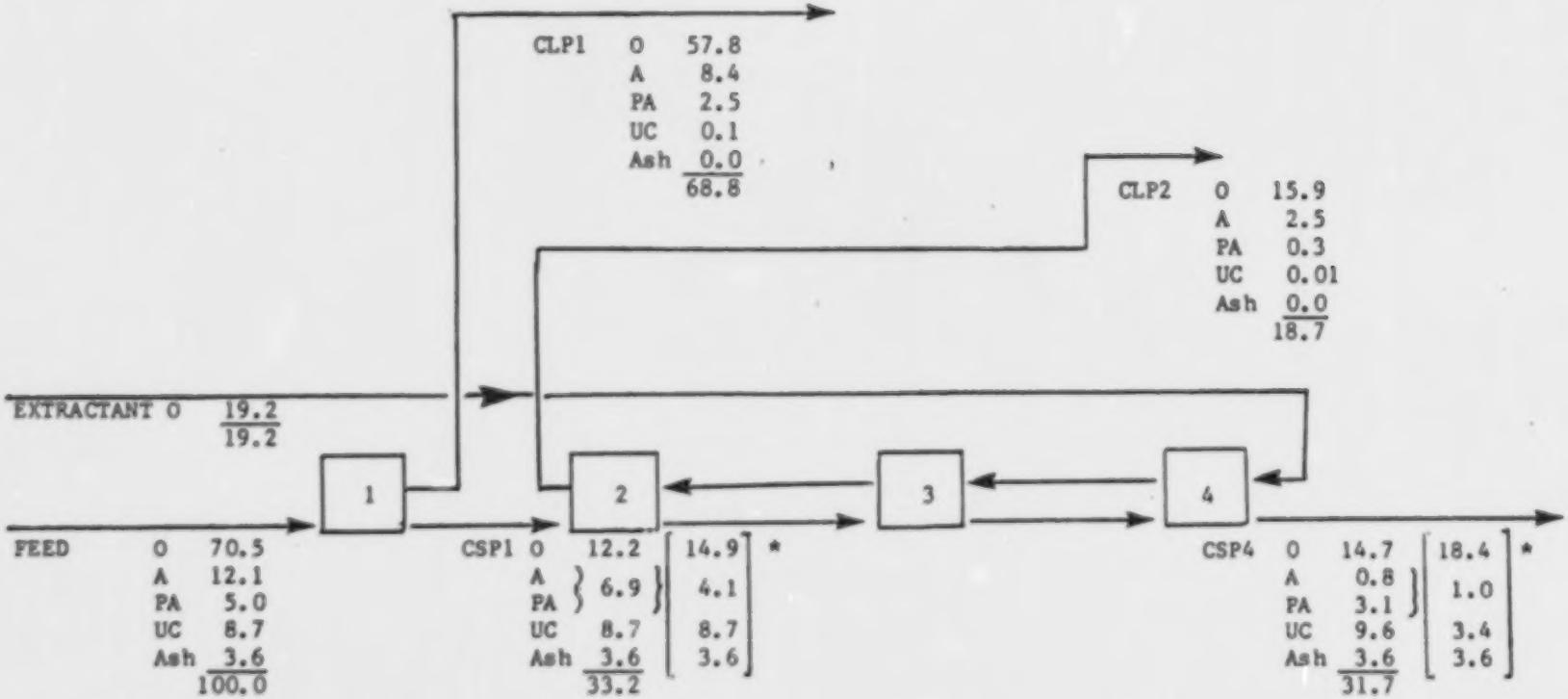
UC Unconverted coal

Ash Ash

Figure 9.8

MATERIAL BALANCE FLOW DIAGRAMS

SAMPLE SFCF 020683



* Value in brackets are theoretical flows calculated on the basis of no precipitation occurring throughout the process

O Oil

A Asphaltenes

PA Pre-asphaltenes

UC Unconverted coal

Ash Ash

10.0 SCALE-UP

Further work on a laboratory-scale is required to finalize the number of stages and process configuration.

At present, work is in progress on the scale-up from laboratory test-tube size to the smallest practical pilot plant size. Besides a large increase in capacity, the transition is being made from batch to continuous processing. In addition, the mode of operation has progressed from total manual to total automative.

The pilot plant separator has been designed for handling and separating such hydrocarbon slurries as tested in this application study. Its particular strength lies in the area of processing separated solids cake with large variations of physical properties in an automative manner. In a normal progression through the different stages of separation and extraction, the physical properties of the separated cake changes from a very viscous, 'sticky' plastic type of material to an incompressible abrasive type of cake. These changes in properties lead to severe difficulties related to the processing of the separated solids.

The designed pilot plant separator has a number of features which distinguishes it from other separators. Those features are directed towards the handling of these special solids in such a manner as to minimize or eliminate their difficult processing characteristics.

Listed below are the majority of features of the pilot plant separator:

PROCESS

- Handles non-filterable solids
- Discharges solids directly into a transfer medium to allow for:
  --relatively trouble-free transfer of difficult materials
  --complete redispersion of solids for effective extraction
- Discharge rate of solids can be varied over a wide range, which has as implication:
  --operation of the unit is not fixed with regard to:
    --clarity of overflow
    --dryness of solids cake
  --the same unit can handle:
    --solids of widely different size distributions
    --solids of different relative densities
  --the same unit is capable of:
    --separation of solids from concentrated slurries for bulk solids removal
    --separation of solids from very dilute slurries for clarification to the ppm concentration

- Process has been tailored to make possible operation at atmospheric pressure
- Unit is completely enclosed which allows for operation in, for instance, an inert gas environment and/or contain harmful or noxious vapours
- Operates as a continuous unit operation (although the 'internal' operation is semi-continuous).

MECHANICAL

- No thrust load on bearings
- Wear on bowl and scraper by solids discharge is limited to scraper wear ring
- Wear on scraper wear ring is minimized by the application of a relatively low speed differential between the ring and the solids
- Operating environment is essentially isolated from the drive mechanism with regard to transfer of mass:
  --solids
  --liquids
  --vapours
- Unit has the capability of operating at relatively high temperatures without unduly overheating the drive mechanism by means of:
  --minimizing the flow of heat between the operating environment and the drive mechanism
  --built-in heat sink, which transfers the 'leaked' energy from the operating environment and the energy generated by the mechanical drive system to a water-cooled heat exchanger
- Design provides for free access to the operating part of the unit to facilitate inspection, cleaning, and maintenance when required
- Operating mechanical features can be altered to suit specific separation requirements without changing the drive mechanism within limitations
- Unit has been designed to allow for addition of additional units with the minimum of interstage transfer equipment to allow for efficient multi-stage extraction/separation
- Special emphasis was placed during the development phase on the objective of accomplishing the process requirements by the simplest mechanical ways to achieve high mechanical reliability

To summarize, the capabilities of this unit which distinguishes it over other centrifugal devices are:

- handling of any type of solids

- operation at relatively high temperatures
- essential complete separation of operating environment and drive mechanism
- independent control of liquid and solids residence times to allow for performance optimization of slurries with different separation characteristics
- capability of discharging the solids directly into a transfer extraction medium to provide a mechanical means of high intensity multi-stage solids/liquids extraction.

Initial commissioning, testing and debugging of the pilot plant separator is expected to be in its final stages by the end of 1985. Scale-up from pilot plant size to either a larger pilot plant unit or, to a commercial unit is not expected to be as difficult a step as going from batch laboratory operation to continuous pilot plant processing.

Going from pilot plant to commercial size will not significantly change the values of the process parameters, such as, for example: separation residence time, G force and flow patterns within the separator. This should result in similar performance at much larger capacities.

The mechanical implications of scale-up to commercial size have been investigated by the engineering company who carried out the detailed mechanical design of the pilot plant unit. Their comments are as quoted below:

"An optimum bowl size was sized assuming a particle acceleration requirement of 3,000 G and a cake thickness of 5 mm. In order to maintain bowl material stresses at an acceptable level it was concluded that a suitable bowl diameter would be 950 mm with a corresponding rotational speed of 2440 rev/min.

Scraper piston loads were estimated on the basis of a friction coefficient of 0.5 between the centrifuged cake and the bowl surface.

This resulted in an axial scraper load of 40,000 lb, requiring an oil pressure of 4800 psi with the present 3 " diameter hydraulic piston.

A review of the standard range of Deublin hydraulic rotary unions indicated that, although the rotational speed requirement had decreased from 4600 to 2440 rev/min, model 2520,000 used for the pilot plant equipment was still the most appropriate model for the scaled-up version.

With a recommended maximum rotary joint operating pressure of 1,000 psi, a hydraulic piston diameter of 7" is required to produce the necessary scraper axial force.

This in turn, would result in increased hydraulic cylinder, separator housing and support bearing diameters."

Basically, they do not foresee any difficulties in scale-up.

11.0 NOTATION

ASH CONCENTRATE (AC)	:	A dull grey, friable and porous solid. A residue product stream in extractant recovery.
ASPHALTENES (A)	:	The fraction of a coal-derived product that is soluble in toluene but insoluble in hexane.
ASPHALTENE AND PRE-ASPHALTENE PRECIPITATION	:	Weight percentage of asphaltenes and pre-asphaltenes precipitated from the liquid phase.
ASPHALTENE AND PRE-ASPHALTENE RECOVERIES	:	For a multi-stage operation, the weight percentage of the asphaltenes and pre-asphaltenes originally in the feed that remain in the solids phase.
COKED MATERIAL	:	Percentage of the interstitital liquids in the concentrated solids phase that is converted into tetrahydrofuran (THF)insoluble organic material.
CONCENTRATED LIQUID PHASE (CLP)	:	Overflow in a separation process concentrated in asphaltenes and pre-asphaltenes.
CONCENTRATED SOLIDS PHASE (CSP)	:	Underflow in a separation process concentrated in solids.
CUMMULATIVE EXTRACTANT:		Weight percentage of extractant added during a stage. For a multi-stage operation, it is the sum of the extractant added at that stage plus the extractant that remains in the concentrated solids phase from previous stages as part of the interstitial liquid.
DRYNESS	:	A measure of the compactness of the concentrated solids phase. or The THF insoluble material contained in the ash concentrate.
GAS PRODUCTION	:	Percentage of the interstitial liquids in the concentrated solids phase that is converted into gaseous non-condensible material.

IBP	:	Initial Boiling Point. As determined by gas chromatography, it is the point at which a cummulative area count equal to 0.5 percent of the total area under the chromatgram is obtained.
LIQUID RECOVERY	:	Percentage of the interstitial liquids in the oncentrated solids phase that is evaporated and recovered.
OIL (O)	:	The hexane-soluble portion of a coal-derived product.
PRE-ASPHALTENES (PA)	:	The fraction of a coal-derived product that is soluble in THF but insoluble in toluene.
QUASI SOLIDS	:	Solids which are insoluble in THF but soluble in cresol.
SEPARATION PROCESS	:	A process consisting of three stages: preparation, separation/extraction and extractant recovery.
SOLIDS	:	The fraction of coal-derived products which is insoluble in THF. Solids consist of unconverted coal and ash.

12.0 REFERENCES

1. Utz B.R., et al., "Solubility Characterization of Coal Derived Products Using Pressure Filtration", Fuel, 63, pp 1671-, 1984.

APPENDIX 1

Experimental Operating Conditions

EXPERIMENTAL OPERATING CONDITIONS

Experiment	Sample	PREPARATION Temp. °C	Type of Extract.	Amt. of Extract. %	SEPARATION/EXTRACTION Temp. °C	Pressure	Residence Time Min.	Force Separation (multiples of gravity)	Extraction Recovery T°C
3 A	SFCF 150284	180	81°C+ Dist.	20	180	atm.	5	1800	N/A
3 B	CSP 3 A	180	81°C+ "	40	180	atm.	5	1800	550
4 A	SFCF 250383	180	NONE "	0	180	atm.	5	1800	550
4 B	SFCF 250383	180	81°C+ "	20	180	atm.	5	1800	550
4 C	SFCF 250383	180	81°C+ "	20	180	atm.	5	1800	N/A
4 D	CSP - 4C	180	81°C+ "	20	180	atm.	5	1800	550
6	SFCF 060284	140	70°C+ "	20	140	atm.	5	1800	550
7	SFCF 261083	140	85°C+ "	20	140	atm.	5	1800	550
8	"	140	85°C+ "	5	140	atm.	5	1800	550
9	" 180°C+	180	180°C+ "	5	180	atm.	5	1800	550
10	"	140	180°C+ "	5	140	atm.	5	1800	550
11	"	140	NONE "	0	140	atm.	5	1800	550
12	" 180°C+	180	NONE "	0	180	atm.	5	1800	550
13 A	" 180°C+	180	180°C+ "	0	180	atm.	5	1800	N/A
13 B	CSP 13 A 180°C+	180	180°C+ "	50	180	atm.	5	1800	N/A
13 C	CSP 13 B 180°C+	180	180°C+ "	50	180	atm.	5	1800	N/A
13 E	CSP 13 C 180°C+	180	180°C+ "	50	180	atm.	5	1800	N/A
15	SFCF 261083 180°C+	180	180°C+ "	10	180	atm.	5	1800	N/A
16	Evaporation of CSP9	-	- -	-	-	-	-	-	480
17	" CSP13E	-	- -	-	-	-	-	-	480
18	" CSP13E	-	- -	-	-	-	-	-	550
20	SFCF 060284 280°C+	180	280°C+ Hexane soluble fraction of feed		180	atm.	5	1800	N/A
21	SFCF 160683 280°C+	180	"		180	atm.	5	1800	N/A
22	SFCF 010684 280°C+	180	"		180	atm.	5	1800	N/A
23	SFCF 020683 280°C+	180	"		180	atm.	5	1800	N/A
24	SFCF 150284 280°C+	180	"		180	atm.	5	1800	N/A
25	SFCF 250384 280°C+	180	"		180	atm.	5	1800	N/A
26	SFCF 270483 280°C+	180	"		180	atm.	5	1800	N/A
27	SFCF 261083 280°C+	180	"		180	atm.	5	1800	N/A

APPENDIX 2

Raw Data and Computer Analysis
of Separation/Extraction Experiments

PROJECT 5136 EXP NO 3A

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weightZ)	ASP+PRE A	SOLIDS	ASH
FEED	14.60	64.51	11.80	1.97	13.77	21.72	6.46
EXTRACT	2.90						
CLP	9.62	85.26	14.68	0.02	14.70	0.05	0.01
CSP	7.17	42.00	NA	NA	14.49	43.51	13.10
LOST SPA	0.00						
LOST EVAP	0.72						
NRML WGHT OF FEED	100.00		NRML AMNT OF EXTRCT IN FEED				0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES CORR FACTOR 0.930

CLP#	10.34	86.28	13.66	0.02	13.68	0.04	0.01

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weightZ)	SOLIDS	ASH
FEED	14.60	64.51	13.77	21.72	6.46
EXTRACT	2.90	2.90			
CLP#	10.34	86.28	13.68	0.04	0.01
CSP	7.17	42.00	14.49	43.51	13.10

NORMALIZED WEIGHTS FACTOR 6.847

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	64.51	13.77	21.72	6.46
EXTRACT	19.88	19.88			
CLP#	70.79	61.08	9.68	0.03	0.01
CSP	49.09	20.62	7.11	21.36	6.43

SOLIDS FREE WEIGHTS

FEED	78.28	64.51	13.77		
EXTRACT	19.88	19.88			
CLP#	70.76	61.08	9.68		
CSP	27.73	20.62	7.11		

UNDILUTED WGHTS		DILUTION AMNTS		14.863	5.017
FEED	100.00	64.51	13.77	21.72	6.46
CLP#	55.93	46.22	9.68	0.03	0.01
CSP	44.07	15.60	7.11	21.36	6.43

NRML AMNT OF EXTRCT IN CLP# 14.86
NRML AMNT OF EXTRCT IN CSP 5.02

MASS BALANCE

IN	119.88	84.39	13.77	21.72	6.46
OUT	119.88	81.70	16.79	21.39	6.44

SOLIDS FREE CONCENTRATIONS (weightZ)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	85.97	14.03	MEASURED VALUES
FEED + EXTRACT	82.95	17.05	CALCULATED "
CLP#	86.32	13.68	
CSP	74.35	25.65	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	82.41	17.59
CLP#	82.68	17.32
CSP	68.68	31.32

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED Z 99.90
UNDILUTED CONCENTR OF ASH IN CLP#Z 0.01

PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPHZ 19.77
(CALCULATED FROM CLP# & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPHZ 2.48
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 25.65

PERCENT DRYNESS: 43.51

PERCENT CUMULATIVE EXTRACTANT: 19.88

++

PROJECT 5136 EXP NO 3B

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	7.17	42.00	NA	14.49	43.51	13.10
EXTRACT	3.01					
CLP	3.38	91.02	8.68	8.88	0.10	0.00
CSP	6.50	40.71	NA	11.36	47.93	14.45
LOST SPA	0.00					
LOST EVAP	0.30					
NRML WGHT OF FEED	49.09		NRML AMNT OF EXTRCT IN FEED			5.02

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR		0.919		
CLP#	3.68	91.75	7.98	8.16	0.09	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	7.17	42.00	14.49	43.51	13.10
EXTRACT	3.01	3.01			
CLP#	3.68	91.75	8.16	0.09	0.00
CSP	6.50	40.71	11.36	47.93	14.45

NORMALIZED WEIGHTS FACTOR 6.847

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	49.09	20.62	7.11	21.36	6.43
EXTRACT	20.60	20.60			
CLP#	25.18	23.10	2.05	0.02	0.00
CSP	44.52	18.12	5.06	21.34	6.43

SOLIDS FREE WEIGHTS

FEED	27.73	20.62	7.11		
EXTRACT	20.60	20.60			
CLP#	25.15	23.10	2.05		
CSP	23.18	18.12	5.06		

UNDILUTED WGHTS		DILUTION AMNTS		14.358	11.266
FEED	44.07	15.60	7.11	21.36	6.43
CLP#	10.82	8.74	2.05	0.02	0.00
CSP	33.25	6.86	5.06	21.34	6.43

NRML AMNT OF EXTRCT IN CLP# 14.36
NRML AMNT OF EXTRCT IN CSP 11.27

MASS BALANCE

IN	69.69	41.22	7.11	21.36	6.43
OUT	69.69	41.22	7.11	21.36	6.43

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	85.28	14.72	MEASURED VALUES
FEED + EXTRACT	85.29	14.71	CALCULATED "
CLP#	91.83	8.17	
CSP	78.18	21.82	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	68.68	31.32
CLP#	80.97	19.03
CSP	57.56	42.44

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	100.00
	UNDILUTED CONCENTR OF ASH IN CLP#%	0.00
PERCENT PRECIPITATION FROM CLP#: (CALCULATED FROM CLP# & CSP MEASUREMENTS)	ASPH + PRE ASPH%	44.49
PERCENT PRECIPITATION FROM CLP#: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	44.51
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		21.82
PERCENT DRYNESS:		47.93
PERCENT CUMULATIVE EXTRACTANT:		58.14

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PROJECT 5136 EXP NO 4A

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	25.58	62.83	15.55	2.51	18.06	19.13	3.53
EXTRACT	0.00						
CLP	13.79	79.57	19.42	0.97	20.39	0.04	0.02
CSP	12.58	43.87	NA	NA	20.04	36.09	6.74
LOST SPA	0.00						
LOST EVAP	0.00						
NRML WGHT OF FEED	100.00			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			1.000		
CLP*	13.79	79.57	19.42	0.97	20.39	0.04	0.02

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	25.58	62.83	18.06	19.13	3.53
EXTRACT	0.00	0.00			
CLP*	13.79	79.57	20.39	0.04	0.02
CSP	12.58	43.87	20.04	36.09	6.74

NORMALIZED WEIGHTS

		FACTOR		3.909	
	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	62.83	18.06	19.13	3.53
EXTRACT	0.00	0.00			
CLP*	53.89	42.88	10.99	0.02	0.01
CSP	49.16	21.57	9.85	17.74	3.31

SOLIDS FREE WEIGHTS

FEED	80.88	62.83	18.06
EXTRACT	0.00	0.00	
CLP*	53.87	42.88	10.99
CSP	31.42	21.57	9.85

UNDILUTED WGHTS		DILUTION AMNTS		0.000	0.000
FEED	100.00	62.83	18.06	19.13	3.53
CLP*	53.89	42.88	10.99	0.02	0.01
CSP	49.16	21.57	9.85	17.74	3.31

NRML AMNT OF EXTRCT IN CLP* 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	100.00	62.83	18.06	19.13	3.53
OUT	103.05	64.45	20.84	17.76	3.32

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	77.68	22.32	MEASURED VALUES
FEED + EXTRACT	75.57	24.43	CALCULATED "
CLP*	79.60	20.40	
CSP	68.64	31.36	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	77.68	22.32
CLP*	79.60	20.40
CSP	68.64	31.36

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED %	99.76
UNDILUTED CONCENTR OF ASH IN CLP*%	0.02
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM CLP* & CSP MEASUREMENTS)	16.52
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	8.63
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:	31.36
PERCENT DRYNESS:	36.09
PERCENT CUMULATIVE EXTRACTANT:	0.00

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PROJECT 5136 EXP NO 49

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	16.70	62.83	15.55	2.51	18.06	19.13	3.53
EXTRACT	3.34						
CLP	12.12	83.32	15.90	0.69	16.59	0.09	0.02
CSP	7.65	40.19	NA	NA	15.44	44.37	6.08
LOST SPA	0.00						
LOST EVAP	0.27						
NRML WGHT OF FEED	100.00			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.978		
CLP*	12.39	83.68	15.56	0.68	16.23	0.09	0.02

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	16.70	62.83	18.06	19.13	3.53
EXTRACT	3.34	3.34			
CLP*	12.39	83.68	16.23	0.09	0.02
CSP	7.65	40.19	15.44	44.37	6.08

NORMALIZED WEIGHTS FACTOR 5.988

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	62.83	18.06	19.13	3.53
EXTRACT	19.98	19.98			
CLP*	74.16	62.05	12.04	0.06	0.01
CSP	45.82	18.41	7.07	20.33	2.78

SOLIDS FREE WEIGHTS

FEED	80.88	62.83	18.06
EXTRACT	19.98	19.98	
CLP*	74.09	62.05	12.04
CSP	25.49	18.41	7.07

UNDILUTED WGHTS		DILUTION AMNTS		15.406	4.572
FEED	100.00	62.83	18.06	19.13	3.53
CLP*	58.75	46.65	12.04	0.06	0.01
CSP	41.25	13.84	7.07	20.33	2.78

NRML AMNT OF EXTRCT IN CLP* 15.41
NRML AMNT OF EXTRCT IN CSP 4.57

MASS BALANCE

IN	119.98	82.80	18.06	19.13	3.53
OUT	119.98	80.47	19.11	20.39	2.80

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	82.10	17.90	MEASURED VALUES
FEED + EXTRACT	80.81	19.19	CALCULATED "
CLP*	83.75	16.25	
CSP	72.25	27.75	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	77.68	22.32
CLP*	79.49	20.51
CSP	66.18	33.82

PERFORMANCE EVALUATION

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED %	99.61
UNDILUTED CONCENTR OF ASH IN CLP*%	0.02
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM CLP* & CSP MEASUREMENTS)	15.34
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	9.24
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:	27.75
PERCENT DRYNESS:	44.37
PERCENT CUMULATIVE EXTRACTANT:	19.98

PROJECT 5136 EXP NO 4C

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	14.19	82.83	15.55	2.51	18.06	19.13	3.53
EXTRACT	2.83						
CLP	10.16	83.55	15.73	0.56	16.32	0.16	0.04
CSP	6.61	39.24	NA	NA	16.71	44.05	8.31
LOST SPA	0.00						
LOST EVAP	0.25						
NRML WGHT OF FEED	100.00		NRML AMNT OF EXTRCT IN FEED				0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES CORR FACTOR 0.976

CLP*	10.41	83.91	15.35	0.54	15.93	0.16	0.04

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	14.19	82.83	18.06	19.13	3.53
EXTRACT	2.83	2.83			
CLP*	10.41	83.91	15.93	0.16	0.04
CSP	6.61	39.24	16.71	44.05	8.31

NORMALIZED WEIGHTS FACTOR 7.046

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	82.83	18.06	19.13	3.53
EXTRACT	19.93	19.93			
CLP*	73.36	61.56	11.69	0.12	0.03
CSP	46.56	18.27	7.78	20.51	3.87

SOLIDS FREE WEIGHTS

FEED	80.88	62.83	18.06
EXTRACT	19.93	19.93	
CLP*	73.24	61.56	11.69
CSP	26.05	18.27	7.78

UNDILUTED WGHTS		DILUTION AMNTS		15.365	4.560
FEED	100.00	82.83	18.06	19.13	3.53
CLP*	58.00	46.19	11.69	0.12	0.03
CSP	42.00	13.71	7.78	20.51	3.87

NRML AMNT OF EXTRCT IN CLP* 15.36
NRML AMNT OF EXTRCT IN CSP 4.56

MASS BALANCE

IN	119.93	82.75	18.06	19.13	3.53
OUT	119.93	79.83	19.47	20.63	3.90

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	82.09	17.91	MEASURED VALUES
FEED + EXTRACT	80.40	19.60	CALCULATED "
CLP*	84.05	15.95	
CSP	70.13	29.87	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	77.68	22.32
CLP*	79.81	20.19
CSP	63.80	36.20

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 99.23
UNDILUTED CONCENTR OF ASH IN CLP*% 0.05

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 18.62
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 10.93
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 29.87

PERCENT DRYNESS: 44.05

PERCENT CUMULATIVE EXTRACTANT: 19.93

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PROJECT 5136 EXP NO 4D

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	6.61	39.24	NA	NA	16.71	44.05	8.31
EXTRACT	2.84						
CLP	3.01	91.99	8.01	0.52	8.53	0.15	0.09
CSP	6.13	38.74	NA	NA	13.83	47.43	8.92
LOST SPA	0.00						
LOST EVAP	0.31						
NRML WGHT OF FEED	46.56			NRML AMNT OF EXTRCT IN FEED			4.56

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES			CORR FACTOR		0.906		
CLP*	3.32	92.14	7.25	0.47	7.72	0.13	0.09

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	6.61	39.24	16.71	44.05	8.31
EXTRACT	2.84	2.84			
CLP*	3.32	92.14	7.72	0.13	0.09
CSP	6.13	38.74	13.83	47.43	8.92

NORMALIZED WEIGHTS — FACTOR 7.045

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	46.56	18.27	7.78	20.51	3.87
EXTRACT	20.01	20.01			
CLP*	23.39	21.55	1.81	0.03	0.02
CSP	43.18	16.73	5.97	20.48	3.85

SOLIDS FREE WEIGHTS

FEED	26.05	18.27	7.78		
EXTRACT	20.01	20.01			
CLP*	23.36	21.55	1.81		
CSP	22.70	16.73	5.97		

UNDILUTED WGHTS		DILUTION AMNTS		13.832	10.736
FEED	42.00	13.71	7.78	20.51	3.87
CLP*	9.56	7.72	1.81	0.03	0.02
CSP	32.44	5.99	5.97	20.48	3.85

NRML AMNT OF EXTRCT IN CLP* 13.83
NRML AMNT OF EXTRCT IN CSP 10.74

MASS BALANCE

IN	66.57	38.28	7.78	20.51	3.87
OUT	66.57	38.28	7.78	20.51	3.87

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	83.11	16.89	MEASURED VALUES
FEED + EXTRACT	83.11	16.89	CALCULATED "
CLP*	92.27	7.73	
CSP	73.69	26.31	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	63.80	36.20
CLP*	81.04	18.96
CSP	50.08	49.92

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	99.49
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.21
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	54.20
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	54.22
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		26.31
PERCENT DRYNESS:		47.43
PERCENT CUMULATIVE EXTRACTANT:		58.49

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PROJECT 5136 EXP NO 6

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	23.96	76.66	7.17	2.50	9.67	13.67	7.27
EXTRACT	4.81						
CLP	18.09	92.11	6.19	1.03	7.22	0.67	0.25
CSP	6.66	46.45	NA	NA	8.40	45.15	23.21
LOST SPA	0.00						
LOST EVAP	4.02						
NRML WGHT OF FEED		100.00		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES CORR FACTOR 0.818

CLP*	22.11	93.54	5.06	0.84	5.91	0.55	0.20

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	23.96	76.66	9.67	13.67	7.27
EXTRACT	4.81	4.81			
CLP*	22.11	93.54	5.91	0.55	0.20
CSP	6.66	46.45	8.40	45.15	23.21

NORMALIZED WEIGHTS FACTOR 4.173

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	76.66	9.67	13.67	7.27
EXTRACT	20.09	20.09			
CLP*	92.29	86.33	5.45	0.51	0.19
CSP	27.80	12.91	2.34	12.55	6.45

SOLIDS FREE WEIGHTS

FEED	86.33	76.66	9.67		
EXTRACT	20.09	20.09			
CLP*	91.78	86.33	5.45		
CSP	15.25	12.91	2.34		

UNDILUTED WGHTS		DILUTION AMNTS		17.478	2.615
FEED	100.00	76.66	9.67	13.67	7.27
CLP*	74.81	68.85	5.45	0.51	0.19
CSP	25.19	10.30	2.34	12.55	6.45

NRML AMNT OF EXTRCT IN CLP* 17.48
NRML AMNT OF EXTRCT IN CSP 2.61

MASS BALANCE

IN	120.09	96.75	9.67	13.67	7.27
OUT	120.09	99.25	7.79	13.06	6.64

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	90.91	9.09	MEASURED VALUES
FEED + EXTRACT	92.72	7.28	CALCULATED "
CLP*	94.06	5.94	
CSP	84.69	15.31	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	88.80	11.20
CLP*	92.66	7.34
CSP	81.52	18.48

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 97.40
UNDILUTED CONCENTR OF ASH IN CLP*% 0.25

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 18.36
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 34.63
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 15.31

PERCENT DRYNESS: 45.15

PERCENT CUMULATIVE EXTRACTANT: 20.09

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PROJECT 5136 EXP NO 7

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	23.73	79.35	11.41 3.57	14.98	5.67	2.69
EXTRACT	4.75					
CLP	21.55	91.83	7.04 1.13	8.17	0.00	0.00
CSP	3.51	21.62	NA NA	30.83	47.55	19.29
LOST SPA	0.00					
LOST EVAP	3.43					
NRML WGHT OF FEED	100.00		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES			CORR FACTOR		0.863		
CLP*	24.97	92.95	6.07	0.97	7.05	0.00	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	23.73	79.35	14.98	5.67	2.69
EXTRACT	4.75	4.75			
CLP*	24.97	92.95	7.05	0.00	0.00
CSP	3.51	21.62	30.83	47.55	19.29

NORMALIZED WEIGHTS FACTOR 4.214

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	79.35	14.98	5.67	2.69
EXTRACT	20.02	20.02			
CLP*	105.23	97.81	7.42	0.00	0.00
CSP	14.79	3.20	4.56	7.03	2.85

SOLIDS FREE WEIGHTS

FEED	94.33	79.35	14.98
EXTRACT	20.02	20.02	
CLP*	105.23	97.81	7.42
CSP	7.76	3.20	4.56

UNDILUTED WGHTS		DILUTION AMNTS	19.390	0.634
FEED	100.00	79.35	14.98	5.67	2.69
CLP*	85.84	78.42	7.42	0.00	0.00
CSP	14.16	2.56	4.56	7.03	2.85

NRML AMNT OF EXTRCT IN CLP* 19.39
NRML AMNT OF EXTRCT IN CSP 0.63

MASS BALANCE

IN	120.02	99.37	14.98	5.67	2.69
OUT	120.02	101.01	11.98	7.03	2.85

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	86.90	13.10	MEASURED VALUES
FEED + EXTRACT	89.40	10.60	CALCULATED "
CLP*	92.95	7.05	
CSP	41.22	58.78	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	84.12	15.88
CLP*	91.36	8.64
CSP	35.99	64.01

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	100.00
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.00
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	33.51
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	46.19
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		58.78
PERCENT DRYNESS:		47.55
PERCENT CUMULATIVE EXTRACTANT:		20.02

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PROJECT 5136 EXP NO 8

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	20.92	79.35	11.41	3.57	14.98	5.67	2.64
EXTRACT	1.05						
CLP	14.11	90.89	8.01	0.87	8.88	0.23	0.35
CSP	3.94	43.24	NA	NA	21.35	35.41	12.52
LOST SPA	0.00						
LOST EVAP	3.92						
NRML WGHT OF FEED	100.00			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR		0.783		
CLP*	18.03	92.87	6.27	0.68	6.95	0.18	0.27

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	20.92	79.35	14.98	5.67	2.64
EXTRACT	1.05	1.05			
CLP*	18.03	92.87	6.95	0.18	0.27
CSP	3.94	43.24	21.35	35.41	12.52

NORMALIZED WEIGHTS — FACTOR 4.781

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	79.35	14.98	5.67	2.64
EXTRACT	5.01	5.01			
CLP*	86.18	80.04	5.99	0.16	0.24
CSP	18.82	8.14	4.02	6.67	2.36

SOLIDS FREE WEIGHTS

FEED	94.33	79.35	14.98
EXTRACT	5.01	5.01	
CLP*	86.03	80.04	5.99
CSP	12.16	8.14	4.02

UNDILUTED WGHTS		DILUTION AMNTS		4.543	0.462
FEED	100.00	79.35	14.98	5.67	2.64
CLP*	81.64	75.49	5.99	0.16	0.24
CSP	18.36	7.68	4.02	6.67	2.36

NRML AMNT OF EXTRCT IN CLP* 4.54
NRML AMNT OF EXTRCT IN CSP 0.46

MASS BALANCE

IN	105.01	84.36	14.98	5.67	2.64
OUT	105.01	88.18	10.01	6.82	2.59

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.92	15.08	MEASURED VALUES
FEED + EXTRACT	89.81	10.19	CALCULATED ,,
CLP*	93.04	6.96	
CSP	66.95	33.05	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	84.12	15.88
CLP*	92.65	7.35
CSP	65.64	34.36

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 91.06
UNDILUTED CONCENTR OF ASH IN CLP*% 0.29

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 31.70
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 53.84
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 33.05

PERCENT DRYNESS: 35.41

PERCENT CUMULATIVE EXTRACTANT: 5.01

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PROJECT 5136 EXP NO 9

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	19.76	75.33	13.63	4.27	17.90	6.77	3.21
EXTRACT	1.00						
CLP	16.05	85.54	10.64	3.61	14.25	0.21	0.10
CSP	3.99	39.47	NA	NA	22.22	38.30	15.69
LOST SPA	0.00						
LOST EVAP	0.72						
NRML WGHT OF FEED		83.70		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA=====SEPARATION & EXTRACTION=========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.957		
CLP*	16.78	86.16	10.18	3.45	13.64	0.20	0.09

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	19.76	75.33	17.90	6.77	3.21
EXTRACT	1.00	1.00			
CLP*	16.78	86.16	13.64	0.20	0.09
CSP	3.99	39.47	22.22	38.30	15.69

NORMALIZED WEIGHTS FACTOR 4.235

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	83.70	63.05	14.98	5.67	2.69
EXTRACT	4.25	4.25			
CLP*	71.05	61.22	9.69	0.14	0.07
CSP	16.89	6.67	3.75	6.47	2.65

SOLIDS FREE WEIGHTS

FEED	78.03	63.05	14.98
EXTRACT	4.25	4.25	
CLP*	70.91	61.22	9.69
CSP	10.42	6.67	3.75

UNDILUTED WGHTS		DILUTION AMNTS		3.829	0.417
FEED	83.70	63.05	14.98	5.67	2.69
CLP*	67.22	57.39	9.69	0.14	0.07
CSP	16.48	6.25	3.75	6.47	2.65

NRML AMNT OF EXTRCT IN CLP* 3.83
NRML AMNT OF EXTRCT IN CSP 0.42

MASS BALANCE

IN	87.95	67.30	14.98	5.67	2.69
OUT	87.95	67.89	13.44	6.61	2.72

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	81.79	18.21	MEASURED VALUES
FEED + EXTRACT	83.47	16.53	CALCULATED "
CLP*	86.34	13.66	
CSP	63.97	36.01	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	80.80	19.20
CLP*	85.56	14.44
CSP	62.47	37.51

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	97.55
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.10
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	17.33
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	24.96
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		36.01
PERCENT DRYNESS:		38.30
PERCENT CUMULATIVE EXTRACTANT:		5.07

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PROJECT 5136 EXP NO 10

RAW DATA----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	24.20	79.35	11.41	3.57	14.98	5.67	2.73
EXTRACT	1.21						
CLP	18.75	90.83	7.44	1.61	9.05	0.12	0.03
CSP	3.78	33.32	NA	NA	26.88	39.85	15.90
LOST SPA	0.00						
LOST EVAP	2.88						
NRML WGHT OF FEED	100.00		NRML AMNT OF EXTRCT IN FEED				0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES			CORR FACTOR		0.867		
CLP*	21.63	92.05	6.45	1.40	7.85	0.10	0.02

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	24.20	79.35	14.98	5.67	2.73
EXTRACT	1.21	1.21			
CLP*	21.63	92.05	7.85	0.10	0.02
CSP	3.78	33.32	26.88	39.85	15.90

NORMALIZED WEIGHTS FACTOR 4.133

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	79.35	14.98	5.67	2.73
EXTRACT	5.01	5.01			
CLP*	89.41	82.30	7.01	0.09	0.02
CSP	15.61	5.20	4.20	6.22	2.48

SOLIDS FREE WEIGHTS

FEED	94.33	79.35	14.98
EXTRACT	5.01	5.01	
CLP*	89.31	82.30	7.01
CSP	9.39	5.20	4.20

UNDILUTED WGHTS		DILUTION AMNTS		4.715	0.298
FEED	100.00	79.35	14.98	5.67	2.73
CLP*	84.69	77.58	7.01	0.09	0.02
CSP	15.31	4.90	4.20	6.22	2.48

NRML AMNT OF EXTRCT IN CLP*	4.71
NRML AMNT OF EXTRCT IN CSP	0.30

MASS BALANCE

IN	105.01	84.36	14.98	5.67	2.73
OUT	105.01	87.50	11.21	6.31	2.50

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.92	15.08	MEASURED VALUES
FEED + EXTRACT	88.65	11.36	CALCULATED "
CLP*	92.15	7.85	
CSP	55.39	44.69	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	84.12	15.88
CLP*	91.71	8.29
CSP	53.93	46.15

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	99.21
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.03
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	30.85
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	47.92
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		44.69
PERCENT DRYNESS:		39.85
PERCENT CUMULATIVE EXTRACTANT:		5.01

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PROJECT 5136 EXP NO 11

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	20.34	79.35	11.41 3.57	14.98	5.67	2.73
EXTRACT	0.00					
CLP	13.45	89.94	NA NA	9.67	0.42	0.11
CSP	3.44	43.54	NA NA	21.16	35.30	13.24
LOST SPA	0.00					
LOST EVAP	3.45					
NRML WGHT OF FEED	100.00		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR		0.796		
CLP*	16.89	91.97	NA	NA	7.70	0.33	0.09

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	20.34	79.35	14.98	5.67	2.73
EXTRACT	0.00	0.00			
CLP*	16.89	91.97	7.70	0.33	0.09
CSP	3.44	43.54	21.16	35.30	13.24

NORMALIZED WEIGHTS FACTOR 4.917

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	79.35	14.98	5.67	2.73
EXTRACT	0.00	0.00			
CLP*	83.06	76.39	6.39	0.28	0.07
CSP	16.94	7.38	3.58	5.98	2.24

SOLIDS FREE WEIGHTS

FEED	94.33	79.35	14.98
EXTRACT	0.00	0.00	
CLP*	82.78	76.39	6.39
CSP	10.96	7.38	3.58

UNDILUTED WGHTS	DILUTION AMNTS		0.000	0.000
FEED	100.00	79.35	14.98	5.67	2.73
CLP*	83.06	76.39	6.39	0.28	0.07
CSP	16.94	7.38	3.58	5.98	2.24

NRML AMNT OF EXTRCT IN CLP* 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	100.00	79.35	14.98	5.67	2.73
OUT	100.00	83.76	9.98	6.26	2.32

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.12	15.88	MEASURED VALUES
FEED + EXTRACT	89.36	10.64	CALCULATED "
CLP*	92.28	7.72	
CSP	67.30	32.70	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	84.12	15.88
CLP*	92.28	7.72
CSP	67.30	32.70

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	97.34
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.09
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	27.44
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	51.37
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		32.70
PERCENT DRYNESS:		35.30
PERCENT CUMULATIVE EXTRACTANT:		0.00

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PROJECT 5136 EXP NO 12

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	21.62	75.33	13.63	4.27	17.90	6.77	3.21
EXTRACT	0.00						
CLP	17.02	84.22	14.34	1.44	15.78	0.00	0.02
CSP	4.31	36.11	NA	NA	22.29	41.60	15.66
LOST SPA	0.00						
LOST EVAP	0.29						
NRML WGHT OF FEED		83.70		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.983		
CLP#	17.31	84.48	14.10	1.42	15.52	0.00	0.02

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	21.62	75.33	17.90	6.77	3.21
EXTRACT	0.00	0.00			
CLP#	17.31	84.48	15.52	0.00	0.02
CSP	4.31	36.11	22.29	41.60	15.66

NORMALIZED WEIGHTS FACTOR 3.871

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	83.70	63.05	14.98	5.67	2.69
EXTRACT	0.00	0.00			
CLP#	67.01	56.61	10.40	0.00	0.02
CSP	16.69	6.03	3.72	6.95	2.61

SOLIDS FREE WEIGHTS

FEED	78.03	63.05	14.98
EXTRACT	0.00	0.00	
CLP#	67.01	56.61	10.40
CSP	9.75	6.03	3.72

UNDILUTED WGHTS		DILUTION AMNTS		0.000	0.000
FEED	83.70	63.05	14.98	5.67	2.69
CLP#	67.01	56.61	10.40	0.00	0.02
CSP	16.69	6.03	3.72	6.95	2.61

NRML AMNT OF EXTRCT IN CLP# 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	83.70	63.05	14.98	5.67	2.69
OUT	83.70	62.64	14.12	6.95	2.63

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	80.80	19.20	MEASURED VALUES
FEED + EXTRACT	81.61	18.39	CALCULATED ,,
CLP#	84.48	15.52	
CSP	61.83	38.17	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	80.80	19.20
CLP#	84.48	15.52
CSP	61.83	38.17

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 99.42
UNDILUTED CONCENTR OF ASH IN CLP#% 0.02

PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPH% 15.64
(CALCULATED FROM CLP# & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPH% 19.18
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 38.17

PERCENT DRYNESS: 41.60

PERCENT CUMULATIVE EXTRACTANT: 0.00

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PROJECT 5136 EXP NO 13A

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	17.82	76.92	10.14	5.23	15.37	7.71	3.42
EXTRACT	0.94						
CLP	14.20	89.37	7.93	2.63	10.56	0.07	0.02
CSP	4.43	45.72	NA	NA	16.43	37.85	12.75
LOST SPA	0.01						
LOST EVAP	0.12						
NRML WGHT OF FEED		83.70		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES			CORR FACTOR		0.991		
CLP*	14.32	89.46	7.86	2.61	10.47	0.07	0.02

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	17.82	76.92	15.37	7.71	3.42
EXTRACT	0.94	0.94			
CLP*	14.32	89.46	10.47	0.07	0.02
CSP	4.43	45.72	16.43	37.85	12.75

NORMALIZED WEIGHTS — FACTOR 4.698

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	83.70	64.38	12.86	6.45	2.86
EXTRACT	4.41	4.41			
CLP*	67.29	60.20	7.04	0.05	0.02
CSP	20.82	9.52	3.42	7.88	2.65

SOLIDS FREE WEIGHTS

FEED	77.25	64.38	12.86		
EXTRACT	4.41	4.41			
CLP*	67.25	60.20	7.04		
CSP	12.94	9.52	3.42		

UNDILUTED WGHTS		DILUTION AMNTS		3.810	0.602
FEED	83.70	64.38	12.86	6.45	2.86
CLP*	63.48	56.39	7.04	0.05	0.02
CSP	20.22	8.92	3.42	7.88	2.65

NRML AMNT OF EXTRCT IN CLP* 3.81
NRML AMNT OF EXTRCT IN CSP 0.60

MASS BALANCE

IN	88.11	68.79	12.86	6.45	2.86
OUT	88.11	69.72	10.46	7.93	2.67

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.25	15.75	MEASURED VALUES
FEED + EXTRACT	86.95	13.05	CALCULATED "
CLP*	89.52	10.48	
CSP	73.56	26.44	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	83.35	16.65
CLP*	88.90	11.10
CSP	72.27	27.73

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	99.46
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.02

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 19.73
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 33.51
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 26.44

PERCENT DRYNESS: 37.85

PERCENT CUMULATIVE EXTRACTANT: 5.27

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PROJECT 5136 EXP NO 138

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	4.43	45.72	NA	16.43	37.85	12.75
EXTRACT	2.22					
CLP	2.61	90.21	8.14	1.01	9.15	0.64	0.03
CSP	3.21	33.07	NA	15.22	51.71	17.57
LOST SPA	0.04					
LOST EVAP	0.78					
NRML WGHT OF FEED	20.82		NRML AMNT OF EXTRCT IN FEED			0.60

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES CORR FACTOR 0.761

CLP*	3.44	92.55	6.19	0.77	6.96	0.49	0.02

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	4.43	45.72	16.43	37.85	12.75
EXTRACT	2.22	2.22			
CLP*	3.44	92.55	6.96	0.49	0.02
CSP	3.21	33.07	15.22	51.71	17.57

NORMALIZED WEIGHTS FACTOR 4.699

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	20.82	9.52	3.42	7.88	2.65
EXTRACT	10.42	10.42			
CLP*	16.15	14.95	1.12	0.08	.00
CSP	15.09	4.99	2.30	7.80	2.65

SOLIDS FREE WEIGHTS

FEED	12.94	9.52	3.42		
EXTRACT	10.42	10.42			
CLP*	16.07	14.95	1.12		
CSP	7.29	4.99	2.30		

UNDILUTED WGHTS		DILUTION AMNTS		8.262	2.758
FEED	20.22	8.92	3.42	7.88	2.65
CLP*	7.89	6.69	1.12	0.08	.00
CSP	12.33	2.23	2.30	7.80	2.65

NRML AMNT OF EXTRCT IN CLP* 8.26

NRML AMNT OF EXTRCT IN CSP 2.76

MASS BALANCE

IN	31.24	19.94	3.42	7.88	2.65
OUT	31.24	19.94	3.42	7.88	2.65

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	85.36	14.64	MEASURED VALUES
FEED + EXTRACT	85.36	14.64	CALCULATED "
CLP*	93.01	6.99	
CSP	68.48	31.52	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	72.28	27.72
CLP*	85.61	14.39
CSP	49.29	50.71

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED %	99.88
UNDILUTED CONCENTR OF ASH IN CLP*%	0.04
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM CLP* & CSP MEASUREMENTS)	52.25
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	52.25
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:	31.52
PERCENT DRYNESS:	51.71
PERCENT CUMULATIVE EXTRACTANT:	54.50

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PROJECT 5136 EXP NO 13C

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	2.76	33.07	NA	NA	15.22	51.71	17.57
EXTRACT	1.38						
CLP	0.57	94.95	0.36	4.42	4.78	0.27	0.00
CSP	3.09	47.31	NA	NA	7.16	45.53	15.42
LOST SPA	0.02						
LOST EVAP	0.46						
NRML WGHT OF FEED	15.09			NRML AMNT OF EXTRCT IN FEED			2.76

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.543		
CLP#	1.06	97.26	0.20	2.40	2.60	0.15	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	2.76	33.07	15.22	51.71	17.57
EXTRACT	1.38	1.38			
CLP#	1.06	97.26	2.60	0.15	0.00
CSP	3.09	47.31	7.16	45.53	15.42

NORMALIZED WEIGHTS FACTOR 5.472

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	15.09	4.99	2.30	7.80	2.65
EXTRACT	7.58	7.58			
CLP#	5.79	5.63	0.15	0.01	0.00
CSP	16.88	7.99	1.21	7.69	2.60

SOLIDS FREE WEIGHTS

FEED	7.29	4.99	2.30
EXTRACT	7.58	7.58	
CLP#	5.78	5.63	0.15
CSP	9.20	7.99	1.21

UNDILUTED WGHTS		DILUTION AMNTS		4.273	6.065
FEED	12.33	2.23	2.30	7.80	2.65
CLP#	1.51	1.35	0.15	0.01	0.00
CSP	10.82	1.92	1.21	7.69	2.60

NRML AMNT OF EXTRCT IN CLP# 4.27
NRML AMNT OF EXTRCT IN CSP 6.06

MASS BALANCE

IN	22.67	12.57	2.30	7.80	2.65
OUT	22.67	13.61	1.36	7.69	2.60

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.55	15.45	MEASURED VALUES
FEED + EXTRACT	90.92	9.08	CALCULATED "
CLP#	97.40	2.60	
CSP	86.86	13.14	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	49.27	50.73
CLP#	90.02	9.98
CSP	61.39	38.61

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 100.00
UNDILUTED CONCENTR OF ASH IN CLP#% 0.00

PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPH% 71.36
(CALCULATED FROM CLP# & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPH% 83.18
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 13.14

PERCENT DRYNESS: 45.53

PERCENT CUMULATIVE EXTRACTANT: 83.85

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PROJECT 5136 EXP NO 13E

RAW DATA----------

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	2.73	47.31	NA	NA	7.16	45.53	15.42
EXTRACT	1.38						
CLP	0.86	95.82	2.10	2.08	4.18	0.00	0.00
CSP	2.72	49.22	NA	NA	4.86	45.92	15.41
LOST SPA	0.04						
LOST EVAP	0.50						
NRML WGHT OF FEED		16.88		NRML AMNT OF EXTRCT IN FEED			6.06

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.616		
CLP*	1.39	97.42	1.29	1.28	2.58	0.00	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	2.73	47.31	7.16	45.53	15.42
EXTRACT	1.38	1.38			
CLP*	1.39	97.42	2.58	0.00	0.00
CSP	2.72	49.22	4.86	45.92	15.41

NORMALIZED WEIGHTS FACTOR 6.187

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	16.88	7.99	1.21	7.69	2.60
EXTRACT	8.52	8.52			
CLP*	8.60	8.38	0.22	0.00	0.00
CSP	16.80	8.27	0.82	7.72	2.59

SOLIDS FREE WEIGHTS

FEED	9.19	7.99	1.21
EXTRACT	8.52	8.52	
CLP*	8.60	8.38	0.22
CSP	9.09	8.27	0.82

UNDILUTED WGHTS		DILUTION AMNTS		7.340	7.245
FEED	10.82	1.93	1.21	7.69	2.60
CLP*	1.26	1.04	0.22	0.00	0.00
CSP	9.56	1.03	0.82	7.72	2.59

NRML AMNT OF EXTRCT IN CLP* 7.34
NRML AMNT OF EXTRCT IN CSP 7.24

MASS BALANCE

IN	25.40	16.51	1.21	7.69	2.60
OUT	25.40	16.65	1.04	7.72	2.59

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	93.18	6.82	MEASURED VALUES
FEED + EXTRACT	94.13	5.87	CALCULATED "
CLP*	97.42	2.58	
CSP	91.01	8.99	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	61.44	38.56
CLP*	82.43	17.57
CSP	55.68	44.32

PERFORMANCE EVALUATION++++++

PROJECT 5136 EXP NO 15

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	12.61	73.76	13.16	4.19	17.35	8.89	3.41
EXTRACT	1.26						
CLP	10.05	84.96	12.57	2.06	14.63	0.41	0.01
CSP	2.97	41.04	NA	NA	16.96	42.00	15.17
LOST SPA	0.05						
LOST EVAP	0.81						
NRML WGHT OF FEED	83.70			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.922		
CLP*	10.91	86.14	11.59	1.90	13.49	0.38	0.01

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	12.61	73.76	17.35	8.89	3.41
EXTRACT	1.26	1.26			
CLP*	10.91	86.14	13.49	0.38	0.01
CSP	2.97	41.04	16.96	42.00	15.17

NORMALIZED WEIGHTS — FACTOR 6.635

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	83.70	61.74	14.52	7.44	2.85
EXTRACT	8.38	8.38			
CLP*	72.37	62.33	9.76	0.27	0.01
CSP	19.72	8.09	3.34	8.28	2.99

SOLIDS FREE WEIGHTS

FEED	76.26	61.74	14.52
EXTRACT	8.38	8.38	
CLP*	72.09	62.33	9.76
CSP	11.44	8.09	3.34

UNDILUTED WGHTS	DILUTION AMNTS		7.420	0.963
FEED	83.70	61.74	14.52	7.44	2.85
CLP*	64.95	54.91	9.76	0.27	0.01
CSP	18.75	7.13	3.34	8.28	2.99

NRML AMNT OF EXTRCT IN CLP* 7.42
NRML AMNT OF EXTRCT IN CSP 0.96

MASS BALANCE

IN	92.08	70.12	14.52	7.44	2.85
OUT	92.08	70.43	13.10	8.55	3.00

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	82.84	17.16	MEASURED VALUES
FEED + EXTRACT	84.31	15.69	CALCULATED "
CLP*	86.46	13.54	
CSP	70.76	29.24	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	80.96	19.04
CLP*	84.91	15.09
CSP	68.07	31.93

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	99.70
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.01
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	13.70
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	21.10
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		29.24
PERCENT DRYNESS:		42.00
PERCENT CUMULATIVE EXTRACTANT:		10.02

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PROJECT 5136 EXP NO 20

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	28.02	76.39	6.02	3.67	9.69	6.18	7.64
EXTRACT	0.00						
CLP	16.84	88.16	9.75	1.40	11.15	0.69	0.00
CSP	10.88	43.96	NA	NA	9.34	46.70	24.29
LOST SPA	0.00						
LOST EVAP	0.30						
NRML WGHT OF FEED		71.97		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.983		
CLP#	17.14	88.37	9.58	1.38	10.96	0.68	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	28.02	76.39	9.69	6.18	7.64
EXTRACT	0.00	0.00			
CLP#	17.14	88.37	10.96	0.68	0.00
CSP	10.88	43.96	9.34	46.70	24.29

NORMALIZED WEIGHTS FACTOR 2.569

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	71.97	54.98	6.97	4.45	5.50
EXTRACT	0.00	0.00			
CLP#	44.03	38.91	4.82	0.30	0.00
CSP	27.94	12.28	2.61	13.05	6.79

SOLIDS FREE WEIGHTS

FEED	67.52	54.98	6.97		
EXTRACT	0.00	0.00			
CLP#	43.73	38.91	4.82		
CSP	14.89	12.28	2.61		

UNDILUTED WGHTS		DILUTION AMNTS		0.000	0.000
FEED	71.97	54.98	6.97	4.45	5.50
CLP#	44.03	38.91	4.82	0.30	0.00
CSP	27.94	12.28	2.61	13.05	6.79

NRML AMNT OF EXTRCT IN CLP#	0.00
NRML AMNT OF EXTRCT IN CSP	0.00

MASS BALANCE

IN	71.97	54.98	6.97	4.45	5.50
OUT	71.97	51.19	7.43	13.35	6.79

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	81.42	10.33	MEASURED VALUES
FEED + EXTRACT	87.32	12.68	CALCULATED "
CLP#	88.97	11.03	
CSP	82.48	17.52	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	81.42	10.33
CLP#	88.97	11.03
CSP	82.48	17.52

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED %	100.00
UNDILUTED CONCENTR OF ASH IN CLP#%	0.00
PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPH% (CALCULATED FROM CLP# & CSP MEASUREMENTS)	13.01
PERCENT PRECIPITATION FROM CLP#: ASPH + PRE ASPH% (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	-6.80
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:	17.52
PERCENT DRYNESS:	46.70
PERCENT CUMULATIVE EXTRACTANT:	0.00

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PROJECT 5136 EXP NO 21

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	24.17	83.20	10.08	2.77	12.85	2.49	1.46
EXTRACT	0.00						
CLP	21.48	88.08	11.92	1.40	13.32	0.06	0.00
CSP	2.37	26.53	NA	NA	37.48	35.99	13.39
LOST SPA	0.00						
LOST EVAP	0.33						
NRML WGHT OF FEED	91.16			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR		0.985		
CLP#	21.80	86.82	11.74	1.38	13.12	0.06	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	24.17	83.20	12.85	2.49	1.46
EXTRACT	0.00	0.00			
CLP#	21.80	86.82	13.12	0.06	0.00
CSP	2.37	26.53	37.48	35.99	13.39

NORMALIZED WEIGHTS FACTOR 3.771

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	91.16	75.85	11.71	2.27	1.33
EXTRACT	0.00	0.00			
CLP#	82.23	71.40	10.79	0.05	0.00
CSP	8.93	2.37	3.35	3.21	1.20

SOLIDS FREE WEIGHTS

FEED	88.89	75.85	11.71
EXTRACT	0.00	0.00	
CLP#	82.18	71.40	10.79
CSP	5.71	2.37	3.35

UNDILUTED WGHTS	DILUTION AMNTS		0.000	0.000
FEED	91.16	75.85	11.71	2.27	1.33
CLP#	82.23	71.40	10.79	0.05	0.00
CSP	8.93	2.37	3.35	3.21	1.20

NRML AMNT OF EXTRCT IN CLP# 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	91.16	75.85	11.71	2.27	1.33
OUT	91.16	73.76	14.13	3.26	1.20

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	85.32	13.18	MEASURED VALUES
FEED + EXTRACT	83.92	16.08	CALCULATED "
CLP#	86.87	13.13	
CSP	41.45	58.55	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	85.32	13.18
CLP#	86.87	13.13
CSP	41.45	58.55

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	100.00
	UNDILUTED CONCENTR OF ASH IN CLP#%	0.00
PERCENT PRECIPITATION FROM CLP#: (CALCULATED FROM CLP# & CSP MEASUREMENTS)	ASPH + PRE ASPH%	18.37
PERCENT PRECIPITATION FROM CLP#: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	0.39
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		58.55
PERCENT DRYNESS:		35.99
PERCENT CUMULATIVE EXTRACTANT:		0.00

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PROJECT 5136 EXP NO 22

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	19.57	81.77	7.89	4.17	12.06	3.53	2.64
EXTRACT	0.00						
CLP	15.77	88.65	9.43	1.91	11.34	0.01	0.00
CSP	3.80	51.11	NA	NA	15.71	33.18	11.46
LOST SPA	0.00						
LOST EVAP	0.00						
NRML WGHT OF FEED		72.62		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES CORR FACTOR 1.000

CLP*	15.77	88.65	9.43	1.91	11.34	0.01	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	19.57	81.77	12.06	3.53	2.64
EXTRACT	0.00	0.00			
CLP*	15.77	88.65	11.34	0.01	0.00
CSP	3.80	51.11	15.71	33.18	11.46

NORMALIZED WEIGHTS FACTOR 3.711

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	72.62	59.38	8.76	2.56	1.92
EXTRACT	0.00	0.00			
CLP*	58.52	51.87	6.64	0.01	0.00
CSP	14.10	7.21	2.22	4.68	1.62

SOLIDS FREE WEIGHTS

FEED	70.06	59.38	8.76
EXTRACT	0.00	0.00	
CLP*	58.51	51.87	6.64
CSP	9.42	7.21	2.22

UNDILUTED WGHTS	DILUTION AMNTS		0.000	0.000
FEED	72.62	59.38	8.76	2.56	1.92
CLP*	58.52	51.87	6.64	0.01	0.00
CSP	14.10	7.21	2.22	4.68	1.62

NRML AMNT OF EXTRCT IN CLP* 0.00

NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	72.62	59.38	8.76	2.56	1.92
OUT	72.62	59.08	8.85	4.69	1.62

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.76	12.50	MEASURED VALUES
FEED + EXTRACT	86.97	13.03	CALCULATED "
CLP*	88.66	11.34	
CSP	76.49	23.51	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	84.76	12.50
CLP*	88.66	11.34
CSP	76.49	23.51

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 100.00

UNDILUTED CONCENTR OF ASH IN CLP*% 0.00

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 12.96
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 9.28
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 23.51

PERCENT DRYNESS: 33.18

PERCENT CUMULATIVE EXTRACTANT: 0.00

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PROJECT 5136 EXP NO 23

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	25.29	70.54	12.13	4.99	17.12	8.73	3.61
EXTRACT	0.00						
CLP	15.77	82.04	13.77	4.19	17.96	0.16	0.00
CSP	8.56	38.97	NA	NA	22.21	38.82	11.60
LOST SPA	0.00						
LOST EVAP	0.96						
NRML WGHT OF FEED	92.25			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.943		
CLP*	16.73	82.92	12.98	3.95	16.93	0.15	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	25.29	70.54	17.12	8.73	3.61
EXTRACT	0.00	0.00			
CLP*	16.73	82.92	16.93	0.15	0.00
CSP	8.56	38.97	22.21	38.82	11.60

NORMALIZED WEIGHTS FACTOR 3.648

TTL WGHT		OIL	ASP+PRE A	SOLIDS	ASH
FEED	92.25	65.07	15.79	8.05	3.33
EXTRACT	0.00	0.00			
CLP*	61.03	50.61	10.33	0.09	0.00
CSP	31.22	12.17	6.93	12.12	3.62

SOLIDS FREE WEIGHTS

FEED	84.20	65.07	15.79		
EXTRACT	0.00	0.00			
CLP*	60.94	50.61	10.33		
CSP	19.10	12.17	6.93		

UNDILUTED WGHTS		DILUTION AMNTS		0.000	0.000
FEED	92.25	65.07	15.79	8.05	3.33
CLP*	61.03	50.61	10.33	0.09	0.00
CSP	31.22	12.17	6.93	12.12	3.62

NRML AMNT OF EXTRCT IN CLP* 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	92.25	65.07	15.79	8.05	3.33
OUT	92.25	62.77	17.27	12.21	3.62

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	77.29	18.76	MEASURED VALUES
FEED + EXTRACT	78.43	21.57	CALCULATED "
CLP*	83.05	16.95	
CSP	63.70	36.30	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	77.29	18.76
CLP*	83.05	16.95
CSP	63.70	36.30

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED %	100.00
UNDILUTED CONCENTR OF ASH IN CLP*%	0.00
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM CLP* & CSP MEASUREMENTS)	21.40
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	9.61
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:	36.30
PERCENT DRYNESS:	38.82
PERCENT CUMULATIVE EXTRACTANT:	0.00

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PROJECT 5136 EXP NO 24

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	23.52	64.97	11.38	1.17	12.55	15.17	6.31
EXTRACT	0.00						
CLP	11.48	84.09	15.36	0.42	15.78	0.12	0.01
CSP	11.94	40.41	NA	NA	16.40	43.19	13.61
LOST SPA	0.00						
LOST EVAP	0.11						
NRML WGHT OF FEED	94.16			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES			CORR FACTOR		0.991		
CLP*	11.59	84.25	15.22	0.42	15.63	0.12	0.01

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	23.52	64.97	12.55	15.17	6.31
EXTRACT	0.00	0.00			
CLP*	11.59	84.25	15.63	0.12	0.01
CSP	11.94	40.41	16.40	43.19	13.61

NORMALIZED WEIGHTS FACTOR 4.003

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	94.16	61.18	11.82	14.28	5.94
EXTRACT	0.00	0.00			
CLP*	46.38	39.07	7.25	0.06	.00
CSP	47.78	19.31	7.84	20.64	6.50

SOLIDS FREE WEIGHTS

FEED	79.88	61.18	11.82	
EXTRACT	0.00	0.00		
CLP*	46.32	39.07	7.25	
CSP	27.14	19.31	7.84	

UNDILUTED WGHTS	DILUTION AMNTS		0.000	0.000
FEED	94.16	61.18	11.82	14.28	5.94
CLP*	46.38	39.07	7.25	0.06	.00
CSP	47.78	19.31	7.84	20.64	6.50

NRML AMNT OF EXTRCT IN CLP* 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	94.16	61.18	11.82	14.28	5.94
OUT	94.16	58.38	15.09	20.69	6.51

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	76.59	14.79	MEASURED VALUES
FEED + EXTRACT	79.47	20.53	CALCULATED "
CLP*	84.35	15.65	
CSP	71.13	28.87	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	76.59	14.79
CLP*	84.35	15.65
CSP	71.13	28.87

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED %	99.92
UNDILUTED CONCENTR OF ASH IN CLP*%	0.01
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM CLP* & CSP MEASUREMENTS)	23.78
PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	-5.80
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:	28.87
PERCENT DRYNESS:	43.19
PERCENT CUMULATIVE EXTRACTANT:	0.00

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PROJECT 5136 EXF NO 25

RAW DATA----------

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	30.78	63.39	15.45	1.93	17.38	15.74	3.49
EXTRACT	0.00						
CLP	16.13	80.87	17.68	1.45	19.13	0.00	0.00
CSP	14.50	45.09	NA	NA	14.30	40.61	7.36
LOST SPA	0.00						
LOST EVAP	0.15						
NRML WGHT OF FEED	100.00			NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES		CORR FACTOR			0.991		
CLP*	16.28	81.04	17.52	1.44	18.96	0.00	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	30.78	63.39	17.38	15.74	3.49
EXTRACT	0.00	0.00			
CLP*	16.28	81.04	18.96	0.00	0.00
CSP	14.50	45.09	14.30	40.61	7.36

NORMALIZED WEIGHTS FACTOR 3.249

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	100.00	63.39	17.38	15.74	3.49
EXTRACT	0.00	0.00			
CLP*	52.89	42.86	10.03	0.00	0.00
CSP	47.11	21.24	6.74	19.13	3.47

SOLIDS FREE WEIGHTS

FEED	84.26	63.39	17.38
EXTRACT	0.00	0.00	
CLP*	52.89	42.86	10.03
CSP	27.98	21.24	6.74

UNDILUTED WGHTS		DILUTION AMNTS	0.000	0.000
FEED	100.00	63.39	17.38	15.74	3.49
CLP*	52.89	42.86	10.03	0.00	0.00
CSP	47.11	21.24	6.74	19.13	3.47

NRML AMNT OF EXTRCT IN CLP* 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	100.00	63.39	17.38	15.74	3.49
OUT	100.00	64.10	16.76	19.13	3.47

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	75.23	20.63	MEASURED VALUES
FEED + EXTRACT	79.27	20.73	CALCULATED "
CLP*	81.04	18.96	
CSP	75.92	24.08	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	75.23	20.63
CLP*	81.04	18.96
CSP	75.92	24.08

==========

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	100.00
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.00

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 8.55
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 8.09
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 24.08

PERCENT DRYNESS: 40.61

PERCENT CUMULATIVE EXTRACTANT: 0.00

++

PROJECT 5136 EXP NO 26

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	26.25	82.07	8.56	3.54	12.10	3.43	2.40
EXTRACT	0.00						
CLP	22.44	84.22	11.92	3.86	15.78	0.00	0.00
CSP	3.40	45.99	NA	NA	15.03	38.88	16.27
LOST SPA	0.00						
LOST EVAP	0.41						
NRML WGHT OF FEED		79.47		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES			CORR FACTOR		0.982		
CLP*	22.85	84.50	11.71	3.79	15.50	0.00	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	26.25	82.07	12.10	3.43	2.40
EXTRACT	0.00	0.00			
CLP*	22.85	84.50	15.50	0.00	0.00
CSP	3.40	45.99	15.03	38.88	16.27

NORMALIZED WEIGHTS .. FACTOR 3.027

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	79.47	65.22	9.62	2.73	1.91
EXTRACT	0.00	0.00			
CLP*	69.18	58.46	10.72	0.00	0.00
CSP	10.29	4.73	1.55	4.00	1.67

SOLIDS FREE WEIGHTS

FEED	76.74	65.22	9.62
EXTRACT	0.00	0.00	
CLP*	69.18	58.46	10.72
CSP	6.29	4.73	1.55

UNDILUTED WGHTS		DILUTION AMNTS		0.000	0.000
FEED	79.47	65.22	9.62	2.73	1.91
CLP*	69.18	58.46	10.72	0.00	0.00
CSP	10.29	4.73	1.55	4.00	1.67

NRML AMNT OF EXTRCT IN CLP* 0.00
NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	79.47	65.22	9.62	2.73	1.91
OUT	79.47	63.19	12.27	4.00	1.67

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	84.98	12.53	MEASURED VALUES
FEED + EXTRACT	83.73	16.26	CALCULATED "
CLP*	84.50	15.50	
CSP	75.25	24.59	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	84.98	12.53
CLP*	84.50	15.50
CSP	75.25	24.59

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS:	AMOUNT OF ASH REMOVED %	100.00
	UNDILUTED CONCENTR OF ASH IN CLP*%	0.00
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM CLP* & CSP MEASUREMENTS)	ASPH + PRE ASPH%	4.66
PERCENT PRECIPITATION FROM CLP*: (CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)	ASPH + PRE ASPH%	-23.69
PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP:		24.59
PERCENT DRYNESS:		38.88
PERCENT CUMULATIVE EXTRACTANT:		0.00

++

PROJECT 5136 EXP NO 27

RAW DATA

FRACTION	WEIGHT (g)	OIL	ASPH	PRE ASPH	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	18.89	74.46	12.11	3.32	15.43	6.14	3.97
EXTRACT	0.00						
CLP	14.27	86.31	11.66	1.99	13.65	0.04	0.00
CSP	4.14	34.04	NA	NA	21.96	44.05	17.67
LOST SPA	0.00						
LOST EVAP	0.47						
NRML WGHT OF FEED		76.22		NRML AMNT OF EXTRCT IN FEED			0.00

ANALYSIS OF RAW DATA======SEPARATION & EXTRACTION==========

CLP CORRECTED FOR LOSSES CORR FACTOR 0.968

CLP*	14.74	86.75	11.29	1.93	13.21	0.04	0.00

CALCULATED VALUES

FRACTION	WEIGHT (g)	OIL	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	18.89	74.46	15.43	6.14	3.97
EXTRACT	0.00	0.00			
CLP*	14.74	86.75	13.21	0.04	0.00
CSP	4.14	34.04	21.96	44.05	17.67

NORMALIZED WEIGHTS FACTOR 4.036

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED	76.22	56.75	11.76	4.68	3.03
EXTRACT	0.00	0.00			
CLP*	59.50	51.61	7.86	0.02	0.00
CSP	16.72	5.69	3.67	7.37	2.95

SOLIDS FREE WEIGHTS

FEED	71.54	56.75	11.76
EXTRACT	0.00	0.00	
CLP*	59.47	51.61	7.86
CSP	9.36	5.69	3.67

UNDILUTED WGHTS	DILUTION AMNTS		0.000	0.000
FEED	76.22	56.75	11.76	4.68	3.03
CLP*	59.50	51.61	7.86	0.02	0.00
CSP	16.72	5.69	3.67	7.37	2.95

NRML AMNT OF EXTRCT IN CLP* 0.00

NRML AMNT OF EXTRCT IN CSP 0.00

MASS BALANCE

IN	76.22	56.75	11.76	4.68	3.03
OUT	76.22	57.31	11.53	7.39	2.95

SOLIDS FREE CONCENTRATIONS (weight%)

	OIL	ASP+PRE ASP	
FEED + EXTRACT	79.33	16.44	MEASURED VALUES
FEED + EXTRACT	83.26	16.76	CALCULATED ,,
CLP*	86.78	13.22	
CSP	60.84	39.25	

UNDILUTED SOLIDS FREE CONCENTRATIONS

FEED	79.33	16.44
CLP*	86.78	13.22
CSP	60.84	39.25

PERFORMANCE EVALUATION++

SEPARATION EFFECTIVENESS: AMOUNT OF ASH REMOVED % 100.00

UNDILUTED CONCENTR OF ASH IN CLP*% 0.00

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 21.12
(CALCULATED FROM CLP* & CSP MEASUREMENTS)

PERCENT PRECIPITATION FROM CLP*: ASPH + PRE ASPH% 19.60
(CALCULATED FROM FEED+EXTRCT & CLP MEASUREMENTS)

PERCENT ASPH+PRE ASPH IN SOLIDS FREE CSP: 39.25

PERCENT DRYNESS: 44.05

PERCENT CUMULATIVE EXTRACTANT: 0.00

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APPENDIX 3

Raw Data and Computer Analysis
of Extractant Recovery Experiments

PROJECT 5136 EXP NO 3B

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE	ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	4.68	40.71	NA	NA	11.36	47.93	14.45
LEFT INJ	0.00						
OIL RCV	NA						
ASH CNC S	0.00						
ASH CNC	2.25	0.00	0.00	0.00	0.00	100.00	33.38
CRACK MTR	NA						

NORMALIZED WEIGHT OF FEED 44.52

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 9.506

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	44.52	18.12	5.06	21.34	6.43
OIL RCV	NA	NA			
ASH CNC*	21.42	0.00	0.00	21.42	7.15
CRCK MTR	NA				

MASS BALANCE

IN	44.52	18.12	5.06	21.34	6.43
OUT	NA	NA	0.00	21.42	7.15

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	NA
PERCENT COKED MTRL:	0.35
PERCENT GAS PRODUCTION:	NA
PERCENT DRYNESS:	100.00

++

PROJECT 5136 EXP NO 4A

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A	ASPH+PRE A (weight%)	SOLIDS	ASH
FEED	2.66	43.87	NA	NA	20.04	36.09	6.74
LEFT INJ	0.10						
OIL RCV	0.99						
ASH CNC S	.00						
ASH CNC	1.23	0.00	0.00	0.00	13.64	86.36	12.33
CRACK MTR	NA						

NORMALIZED WEIGHT OF FEED 49.16

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 19.155

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	49.16	21.57	9.85	17.74	3.31
OIL RCV	19.03	19.03			
ASH CNC*	23.52	0.00	3.21	20.32	2.90
CRCK MTR	6.60				

MASS BALANCE

IN	49.16	21.57	9.85	17.74	3.31
OUT	49.16	19.03	3.21	20.32	2.90

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	60.58
PERCENT COKED MTRL:	8.19
PERCENT GAS PRODUCTION:	21.02
PERCENT DRYNESS:	86.36

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PROJECT 5136 EXP NO 4B

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE (weight%)	ASPH+PRE A (weight%)	SOLIDS	ASH
FEED	2.44	40.19	NA	NA	15.44	44.37	6.08
LEFT INJ	0.19						
OIL RCV	1.24						
ASH CNC S	0.00						
ASH CNC	0.81	0.00	0.00	0.00	0.00	100.00	18.95
CRACK MTR	NA						

NORMALIZED WEIGHT OF FEED 45.82

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 20.403

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	45.82	18.42	7.07	20.33	2.79
OIL RCV	25.26	25.26			
ASH CNC*	16.59	0.00	0.00	16.59	3.14
CRCK MTR	3.97				

MASS BALANCE

IN	45.82	18.42	7.07	20.33	2.79
OUT	45.82	25.26	0.00	16.59	3.14

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: 99.10

PERCENT COKED MTRL: -14.67

PERCENT GAS PRODUCTION: 15.57

PERCENT DRYNESS: 100.00

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PROJECT 5136 EXP NO 4D

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	2.44	38.74	NA	13.83	47.43	8.92
LEFT INJ	0.04					
OIL RCV	1.14					
ASH CNC S	0.00					
ASH CNC	1.06	0.00	0.00	0.00	100.00	21.03
CRACK MTR	NA					
NORMALIZED WEIGHT OF FEED		43.18				

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS	TTL WGHT	FACTOR OIL	ASP+PRE A	17.942 SOLIDS	ASH
FEED*	43.18	16.73	5.97	20.48	3.85
OIL RCV	20.53	20.53			
ASH CNC*	19.06	0.00	0.00	19.06	4.01
CRCK MTR	3.59				
MASS BALANCE					
IN	43.18	16.73	5.97	20.48	3.85
OUT	43.18	20.53	0.00	19.06	4.01

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	90.42
PERCENT COKED MTRL:	-6.24
PERCENT GAS PRODUCTION:	15.82
PERCENT DRYNESS:	100.00

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PROJECT 5136 EXP NO 6

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A (weight%)	ASPH	ASP+PRE A	SOLIDS	ASH
FEED	2.51	46.45	NA	NA	8.40	45.15	23.21
LEFT INJ	0.11						
OIL RCV	NA						
ASH CNC S	0.00						
ASH CNC	1.25	0.00	0.00	0.00	0.00	100.00	47.37
CRACK MTR	NA						

NORMALIZED WEIGHT OF FEED 27.80

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 11.592

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	27.80	12.91	2.34	12.55	6.45
OIL RCV	NA	NA			
ASH CNC*	14.52	0.00	0.00	14.52	6.88
CRCK MTR	NA				

MASS BALANCE

IN	27.80	12.91	2.34	12.55	6.45
OUT	NA	NA	0.00	14.52	6.88

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: NA

PERCENT COKED MTRL: 12.92

PERCENT GAS PRODUCTION: NA

PERCENT DRYNESS: 100.00

++

PROJECT 5136 EXP NO 7

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A	ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	1.39	21.62	NA	NA	30.83	47.55	19.29
LEFT INJ	.00						
OIL RCV	0.41						
ASH CNC S	0.01						
ASH CNC	0.91	0.00	0.00	0.00	0.00	100.00	30.97
CRACK MTR	NA						
NORMALIZED WEIGHT OF FEED		14.79					

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 10.688

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	14.79	3.20	4.56	7.03	2.85
OIL RCV	4.39	4.39			
ASH CNC*	9.78	0.00	0.00	9.78	3.03
CRCK MTR	0.62				

MASS BALANCE

IN	14.79	3.20	4.56	7.03	2.85
OUT	14.79	4.39	0.00	9.78	3.03

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: 56.54

PERCENT COKED MTRL: 35.44

PERCENT GAS PRODUCTION: 8.02

PERCENT DRYNESS: 100.00

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PROJECT 5136 EXP NO 8

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A (weight%)	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	1.48	43.24	NA	NA	21.35	35.41	12.52
LEFT INJ	0.01						
OIL RCV	0.68						
ASH CNC S	0.01						
ASH CNC	0.66	0.00	0.00	0.00	0.00	100.00	30.02
CRACK MTR	NA						

NORMALIZED WEIGHT OF FEED 18.82

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 12.781

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	18.82	8.14	4.02	6.66	2.36
OIL RCV	8.74	8.74			
ASH CNC*	8.59	0.00	0.00	8.59	2.58
CRCK MTR	1.48				

MASS BALANCE

IN	18.82	8.14	4.02	6.66	2.36
OUT	18.82	8.74	0.00	8.59	2.58

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: 71.92

PERCENT COKED MTRL: 15.88

PERCENT GAS PRODUCTION: 12.21

PERCENT DRYNESS: 100.00

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PROJECT 5136 EXP NO 9

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE (weight%)	ASPH A	ASP+PRE A	SOLIDS	ASH
FEED	1.76	39.47	NA	NA	22.22	38.30	15.69
LEFT INJ	0.01						
OIL RCV	0.72						
ASH CNC S	0.01						
ASH CNC	0.96	0.00	0.00	0.00	0.00	100.00	31.50
CRACK MTR	NA						
NORMALIZED WEIGHT OF FEED		16.89					

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 9.610

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	16.89	6.67	3.75	6.47	2.65
OIL RCV	6.94	6.94			
ASH CNC*	9.34	0.00	0.00	9.34	2.94
CRCK MTR	0.60				

MASS BALANCE

IN	16.89	6.67	3.75	6.47	2.65
OUT	16.89	6.94	0.00	9.34	2.94

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	66.62
PERCENT COKED MTRL:	27.59
PERCENT GAS PRODUCTION:	5.78
PERCENT DRYNESS:	100.00

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PROJECT 5136 EXP NO 10

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	2.96	33.32	NA	26.88	39.85	15.90
LEFT INJ	0.34					
OIL RCV	1.01					
ASH CNC S	0.01					
ASH CNC	1.47	0.00	0.00	0.00	100.00	31.40
CRACK MTR	NA					

NORMALIZED WEIGHT OF FEED 15.61

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 5.966

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	15.61	5.20	4.20	6.22	2.48
OIL RCV	6.05	6.05			
ASH CNC*	8.78	0.00	0.00	8.78	2.76
CRCK MTR	0.78				

MASS BALANCE

IN	15.61	5.20	4.20	6.22	2.48
OUT	15.61	6.05	0.00	8.78	2.76

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	64.43
PERCENT COKED MTRL:	27.31
PERCENT GAS PRODUCTION:	8.26
PERCENT DRYNESS:	100.00

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PROJECT 5136 EXP NO 11

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE	ASPH (weight%)	ASP+PRE A	SOLIDS	ASH
FEED	1.56	43.54	NA	NA	21.16	35.30	13.24
LEFT INJ	0.02						
OIL RCV	0.72						
ASH CNC S	0.03						
ASH CNC	0.71	0.00	0.00	0.00	0.00	100.00	46.70
CRACK MTR	NA						

NORMALIZED WEIGHT OF FEED 16.94

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 11.065

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	16.94	7.38	3.58	5.98	2.24
OIL RCV	8.00	8.00			
ASH CNC*	8.16	0.00	0.00	8.16	3.81
CRCK MTR	0.78				

MASS BALANCE

IN	16.94	7.38	3.58	5.98	2.24
OUT	16.94	8.00	0.00	8.16	3.81

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: 72.99

PERCENT COKED MTRL: 19.89

PERCENT GAS PRODUCTION: 7.12

PERCENT DRYNESS: 100.00

++

PROJECT 5136 EXP NO 12

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A	ASP+PRE A (weight%)	SOLIDS	ASH
FEED	2.16	36.11	NA	22.29	41.60	15.66
LEFT INJ	0.04					
OIL RCV	0.74					
ASH CNC S	0.01					
ASH CNC	1.18	0.00	0.00	0.00	100.00	32.89
CRACK MTR	NA					

NORMALIZED WEIGHT OF FEED 16.69

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 7.884

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	16.69	6.03	3.72	6.94	2.61
OIL RCV	5.81	5.81			
ASH CNC*	9.37	0.00	0.00	9.37	3.08
CRCK MTR	1.51				

MASS BALANCE

IN	16.69	6.03	3.72	6.94	2.61
OUT	16.69	5.81	0.00	9.37	3.08

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: 59.57

PERCENT COKED MTRL: 24.90

PERCENT GAS PRODUCTION: 15.53

PERCENT DRYNESS: 100.00

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PROJECT 5136 EXP NO 16

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE (weight%)	ASPH	ASP+PRE A	SOLIDS	ASH
FEED	1.61	41.49	NA	NA	20.21	38.30	17.04
LEFT INJ	0.01						
OIL RCV	0.67						
ASH CNC S	0.01						
ASH CNC	0.93	0.00	0.00	0.00	0.00	100.00	31.50
CRACK MTR	0.00						

NORMALIZED WEIGHT OF FEED 16.89

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 10.529

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	16.89	7.01	3.41	6.47	2.88
OIL RCV	7.05	7.05			
ASH CNC*	9.84	0.00	0.00	9.84	3.10
CRCK MTR	0.00				

MASS BALANCE

IN	16.89	7.01	3.41	6.47	2.88
OUT	16.89	7.05	0.00	9.84	3.10

==========

PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY: 67.70

PERCENT COKED MTRL: 32.30

PERCENT GAS PRODUCTION: 0.00

PERCENT DRYNESS: 100.00

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PROJECT 5136 EXP NO 17

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A (weight%)	ASPH+PRE A (weight%)	SOLIDS	ASH
FEED	1.10	49.22	NA	NA	4.86	45.92	15.41
LEFT INJ	0.00						
OIL RCV	0.61						
ASH CNC S	0.01						
ASH CNC	0.54	0.00	0.00	0.00	0.00	100.00	32.08
CRACK MTR	NA						
NORMALIZED WEIGHT OF FEED		16.80					

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 15.314

	TTL W&HT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	16.80	8.27	0.82	7.71	2.59
OIL RCV	8.40	8.40			
ASH CNC*	8.40	0.00	0.00	8.40	2.70
CRCK MTR	0.00				

MASS BALANCE

IN	16.80	8.27	0.82	7.71	2.59
OUT	16.80	8.40	0.00	8.40	2.70

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PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	92.44
PERCENT COKED MTRL:	7.56
PERCENT GAS PRODUCTION:	0.00
PERCENT DRYNESS:	100.00

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PROJECT 5136 EXP NO 18

RAW DATA----FLASH RECOVERY----------

FRACTION	WEIGHT (g)	OIL	ASPH PRE A	ASPH+PRE A (weight%)	SOLIDS	ASH
FEED	0.87	49.22	NA	4.86	45.92	15.41
LEFT INJ	0.00					
OIL RCV	0.23					
ASH CNC S	.00					
ASH CNC	0.41	0.00	0.00	0.00	100.00	32.78
CRACK MTR	NA					

NORMALIZED WEIGHT OF FEED 16.80

ANALYSIS OF RAW DATA======FLASH RECOVERY==========

NORMALIZED WEIGHTS FACTOR 19.218

	TTL WGHT	OIL	ASP+PRE A	SOLIDS	ASH
FEED*	16.80	8.27	0.82	7.71	2.59
OIL RCV	4.40	4.40			
ASH CNC*	7.88	0.00	0.00	7.88	2.58
CRCK MTR	4.52				

MASS BALANCE

IN	16.80	8.27	0.82	7.71	2.59
OUT	16.80	4.40	0.00	7.88	2.58

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PERFORMANCE EVALUATION++++++++FLASH RECOVERY++++++++++++++++++++++++++++++

PERCENT LIQUID RECOVERY:	48.42
PERCENT COKED MTRL:	1.83
PERCENT GAS PRODUCTION:	49.75
PERCENT DRYNESS:	100.00

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